

# THE BIOLOGIST

A Quarterly Journal Promoting Research  
Interest in the Biological Sciences

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# THE BIOLOGIST

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## THE ROLE OF THE GRADUATE STUDENT IN THE RESEARCH PROGRAM OF THE UNIVERSITY

By C. A. ELVEHJEM,

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Wisconsin Chapter\**

I imagine many of you graduate students will say that you know better than anyone else, the role which you are playing in the research project with which you are associated. I agree with you and if you don't know you are a poor graduate student. If I should attempt to tell you that you do not play an important role, you could easily reply that I do not understand research. Seriously, the graduate student is a very important part of most research programs in any modern university. Let us consider why this is true, what it means to the university and the student and what problems we may have to face in the future as a result of this cooperative effort.

Before discussing the relation between research and graduate work we need to know something about the historical development of our present day research program. You must realize that research did not originate in what we know today as a modern university. The university we know today developed largely in France and Italy at the beginning of the second half of the middle ages; Oxford in 1264, Prague

in 1348, Vienna in 1365. Experimentation was carried on but the early laboratories were found in the bedrooms or kitchens of the experimenters. Newton's optical researches were made in his home. Robert Boyle tested his laws of elasticity of gases in tubes along the stairs. Furthermore, these men made reports of their results at learned societies. The Royal Society of London, founded in 1660, resulted from such informal meetings. Because there was so much dogmatism and control in the universities of the 17th and 18th centuries scientific men found greater freedom and stimulus in these learned societies. There were, of course, a few exceptions. For example, Galileo was Professor at the University of Padua from 1592 to 1610 and was then called to the University of Pisa without any obligation to teach. He probably held the first research professorship.

In America during the colonial period, scientific work was carried out sporadically and for the most part, outside the universities. Franklin and Jefferson are outstanding workers who were not attached to academic institutions. Neither government nor private funds were available for the promotion of pure research until the latter part of the 19th century. In contrast, there

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\*Based upon an address presented at a meeting sponsored by Zeta Chapter of Phi Sigma.

was greater governmental interest in research in Germany at the beginning of the 19th century. The University of Berlin was founded in 1809. Wilhelm von Humboldt, Head of this institution, looked upon the University not only as an institution with the highest scholarly and scientific instruction but at the same time to be a center for research and investigation. Although Harvard was incorporated in 1650, William and Mary established in 1693, Yale in 1701 and Princeton in 1746, none of these institutions established graduate work or stimulated a definite research program for many years. We might mention that Harvard sent out a party to observe the total solar eclipse of 1780 and that the Harvard Observatory was erected in 1847. Wisconsin was not too far behind since our Washburn Observatory was built in 1878.

The United States Government slowly established scientific bureaus needed to fulfill its obligation to the public. The Coast and Geodetic Survey, the Naval Observatory, the Department of Agriculture and the Geological Survey were some of the important bureaus established. Today we have over 40 such Federal agencies. The first large sum from private sources was given by James Smithson, an Englishman, in the amount of \$550,000. The bequest was debated in Congress for ten years before the Smithsonian Institution was finally established. Fortunately, research has also benefited from many individual grants and grants from foundations such as the Carnegie Institute and Rockefeller Foundation.

In 1857 Mr. Justin Morrill, a representative from the State of Vermont, introduced a bill "donating public lands to several states and territories which may provide colleges for the benefit of agricultural and mechanical arts." Although it was vetoed by President Buchanan, it was reintroduced in Congress in 1862 and signed by President Lincoln. Professor Cuberley has given the following account of the importance of this Act:

"Probably no aid for education given by the National Government to the States has proved so fruitful as have these grants of land, and subsequently of money, for instruction in agriculture

and mechanic arts. New and vigorous colleges have been created (Cornell, Purdue, and the state universities of Ohio and Illinois are examples); small and feeble state universities have been awakened into new life (Vermont and Wisconsin for examples); agriculture and engineering have been developed as new learned professions; and the States have been stimulated to make larger and rapidly increasing appropriations for their universities, until today the state universities largely overshadow all but the best endowed of the old denominational colleges."

By 1884 we had an experiment station at Wisconsin with three research workers but only one 4-year student had graduated in agriculture. All of these things increased university interest and responsibility in the field of applied research and development. Universities became centers for scholars who were not only interested in disseminating information but in creative research work. A long struggle for academic freedom had provided our universities with a means of protecting the scientist from many of the immediate pressures of convention or prejudice.

Toward the latter part of the 19th century the stage was set for a combination of research and graduate work. The spectacular results of some of the early experimental work, the recognition of the importance of exacting methods used in German universities and the need for workers in applied fields became obvious to those who were looking for improvements in our educational program of this country.

The first graduate school, and some say the first real university in this country, was organized at Johns Hopkins in 1876. Let me quote a few phrases from the Third Annual Report of the Johns Hopkins University in 1878. The requirements for the doctorate of philosophy degree were that each candidate devote "his attention to one main subject and one subsidiary subject." It was required that these primary subjects be "sufficiently broad to require prolonged and arduous study, and that the secondary subject be pertinent to the principal theme." It was expected that each candidate have a reading knowledge of Latin, French



and German. In 1888 Latin was dropped. Likewise, it was expected that the candidate show evidence of acquaintance with the methods of modern scientific research. In every case the candidate must present an elaborate thesis on a topic approved by his chief adviser. "The preparation of this thesis requires labor for the greater part of an academic year and the completed paper is supposed to show the candidates' mastery of his subject, his power of independent thought as well as of careful research, and his ability to express, in clear and systematic order, and in appropriate language, the results of his study."

These statements sound very familiar and you may say that graduate schools have been slow to modernize their requirements. However, I am more inclined to believe that President Gilman's statement covered the requirements so well that they cannot be improved upon. You will notice that nothing is said about courses and credits and my hope is that they will always be minimized. This does not mean that I am opposed to courses since there can be no objection to teaching the methods of modern research in fundamental courses when possible. Otherwise, with the large number of graduate students, the cost would be prohibitive.

Other universities followed in rapid order—Columbia 1880, Clark University and Catholic University 1889, Harvard 1890, Yale 1892. One of the first State universities to organize graduate work was the University of Nebraska in 1886. Wisconsin granted its first Ph.D. degree in 1892 to Charles Van Hise who later became the University's eighth President. The graduate school was made a definite division of the University in 1904. In that year we had 115 graduate students—105 in L. and S., 7 in Engineering and 3 in Agriculture.

The growth of graduate work during the first decade was not rapid due largely, I imagine, to lack of support for graduate students. In 1920 there were 15,600 graduate students in the United States and 432 Ph.D.'s were granted. By 1940 the number of graduate students had increased six times—to 106,000 and 3,290 Ph.D.'s were granted. The reason for this is obvious.

An increased amount of funds for research became available which was followed by an increased demand for trained personnel. Industrial research was greatly stimulated by World War I. It has been estimated that the number of research workers and the amount of funds have doubled each ten years since 1900.

From 1930 to 1940 funds for industrial research increased from 116 to 240 million, for government research from 24 to 69 million and for university research from 20 to 31 million. More funds attracted more graduate students, gave more facilities for research and stimulated faculty members to take over organized research. Organized research or project research has played an important role at Wisconsin. In 1918 President Van Hise appointed a research committee and soon thereafter the Legislature made available \$23,000 per year for special investigations. This fund has now increased to \$100,000 per year. In 1928 the Wisconsin Alumni Research Foundation made available a small amount of money for project research. During the past 20 years a total of over \$3,000,000 has been supplied. The important thing is that a very large percentage of these funds has been used for the support of graduate students. The value is perfectly obvious. The professor doing a limited amount of research encountered many new ideas which he would like to follow in greater detail. The availability of graduate assistants gave this professor an opportunity to carry out his work. The professor profited, the student gained greatly from the close association with the professor and the university gained in research prestige.

A definite pattern has been set in which funds are granted to an individual professor to carry out a specific problem. Up to a certain point this is a correct program since the center of growth is in an individual with vision around whom others aggregate. However, as we shall see later this program may have been so successful that we have reached a point where there is a shortage of senior investigators. Every new program for this supported research includes a fellowship program. The National Institute of Health has its fellowship program. The National

Foundation for Infantile Paralysis and the Committee on Growth emphasize training through fellowships. The proposed National Science Foundation has a Division of Scientific Personnel and Education. The function of this division is to support and to supervise the granting of scholarships and fellowships in science.

Thus the role of the graduate student is not only recognized but it is recognized in terms of dollars and cents. Even industry is increasing its contributions for fellowships in universities. At our own institution last year, industry gave us \$136,000 for research and \$140,000 for fellowships where no definite research was specified. What does this mean? It means an excellent training program for the student. It means increased research productivity for the University, generally at reduced cost, and it means that the student is better prepared to take up independent research after he receives his degree. In most cases the student fits into a going research program which gives him greater encouragement in his early period and gives him an opportunity to help supervise younger men during the latter part of his graduate period. The student has an opportunity to become acquainted with other research projects and usually is not limited in developing his own ideas. He is not subject to a Director of Research, an Associate Director of Research, an Assistant Director of Research, a Laboratory Director, etc., which are usually encountered in large industrial laboratories. It usually means that the student has an opportunity for publication and this adds to his scientific stature.

Now, what should the student do as a partner in this research project? If he is assigned a study desk, a laboratory bench and equipment, he should keep them in tip-top shape. I don't believe time would be wasted if he took five minutes every morning to clean up his desk. I have known one or two exceptions, but you can usually tell from the condition of the student's desk and lab bench, how clearly his mind works. He should familiarize himself with the problem assigned as rapidly as possible. He should have his own plan and not only the professor's. He

should do the routine work necessary for the project to progress, willingly and diligently. He should certainly keep up with the literature related to his special problem and he might try to bring the professor an obscure paper which the professor had not seen. It would not be too serious if he came up with a brilliant new idea once in a while. Finally, he might be thinking about summarizing his data and even try preparing the work for publication before the professor calls for it. Such preliminary drafts, even if the results were not complete enough for publication, would be of great help in writing the thesis or preparing a report for Journal Club. I should also add that the student should not be afraid to discuss his results with his fellow workers. Graduate students will often spend their last cent to go to a scientific meeting in order to discuss results freely with other workers but will often have a great hesitancy in discussing results with a desk partner.

Now, you may ask, what does the professor do or what should he do? Well, he should follow about the same outline. He should see that the conditions under which the student works are satisfactory. He should check on the student's technique and he might come up with a new idea once in a while and find some new literature pertaining to the problem. There is one thing that he should not do, and that is, discourage the student from trying something which looks very foolish. That is the advantage of this type of arrangement. The student and the professor can try the craziest ideas and if they do not work nobody needs to know about it except these two. During the war Homer Adkins pointed out that the greatest disadvantage of group research or committee planned research was that no one dared stick his neck out and therefore a really new approach was not suggested for fear of criticism by the other members. A vision usually comes to one man and the graduate student has the privilege of sharing this with his professor. This does not mean that the original idea may not first come to the student and in this case the professor can share it with his co-workers. It is unnecessary here to list the numerous examples of the



new and novel ideas coming from a student.

It is a give and take proposition and in most cases the arrangement is ideal but like any successful venture, it may lead to numerous difficulties. What are some of the problems which we must face?

(1) It must be recognized that in some fields the graduate student does not fit into a research program as readily as he does in most natural sciences. In some cases the professor must do the work directly and can receive little help from the graduate student. We must also recognize that some professors prefer to do their own research work rather than rely upon help, however competent. A university should always recognize this point of view and not force a faculty member to use graduate students in his work if he feels it is not satisfactory. This does not mean that this professor will not supervise graduate work but the student will not have the opportunity to work in as close a relationship.

(2) When a student takes part in a definite research program he shares directly in the successes and disappointments. A student may take part in a project shortly before a very significant discovery is made or when results are forthcoming rapidly. He may not realize the great amount of effort which has gone into the earlier work and therefore concludes that research is all glamour with little work. Such students may be badly disillusioned when they take up their own work and find that they may have to struggle many years before they can make a significant contribution. Conversely, a student may be assigned to a problem which has reached a stalemate and he may struggle for a long time with few results. This may affect his enthusiasm for research during his entire lifetime. The redeeming feature in this case is that during a three or four year period both successes and disappointments are met and the student usually gets a pretty good look at the realities of research. That is why I believe a student should start some sort of research work at the very beginning of his graduate career, and follow it all the way through. Don't delay starting until

after the preliminary examinations are off. That is the only objection I have to Gilman's original plan—namely "The preparation of this thesis requires labor for the greater part of an academic year." Certainly in the experimental fields very little can be accomplished in one year and I doubt that the true research spirit can be developed in a man in less than three years.

(3) The greatest criticism of our training program involving this close relationship between research and graduate students, is that we are training only research workers. Some say that this specialization is little above specialized technology. Even men in industry raise their voices—for example—"Our research men are of the general opinion that graduate study on the Ph.D. level today results in narrowing the individual from a standpoint of scientific background and interests as well as a noticeable deficiency in matters of nonscientific nature."

"Too many graduates are specialists lacking a broad knowledge of basic science which can be applied to a variety of research problems. In the rapidly changing scientific world today, versatility is essential to progress. Too great specialization in training leads to specialization in action afterwards, resulting in mental atrophy and shallow thinking outside the field of specialization."

And finally, the statement made by C. A. Thomas, Executive Vice President of the Monsanto Chemical Company, has been referred to very frequently during the past few months. "Are we becoming nut-tighteners and wrench-wielders on an assembly line of industrial and university research? Perhaps we have straitjacketed our imaginations within the confines of narrow disciplines and lost sight of the end product." Of course, our answer is that training of this kind does not occur at the University of Wisconsin. Perhaps I should not try to answer these accusations. It may do us some good to think about it but the criticism comes not only from the outside but our academic friends also raise their voices. They state that the majority of the Ph.D.'s do not become research workers in any productive sense but become teachers or administrators. It

is true that in some fields there is little opportunity for research but certainly in most of the fields represented here tonight, a properly trained Ph.D. man has opportunity to do productive research.

I have gone over the first 100 Ph.D. degrees granted in Biochemistry and I find that 90% of living individuals still have a close relationship to research. Many of them are also teachers but sorry to say, only a few have become Presidents or Vice Presidents. Perhaps research trained men should have more to say in the running of industry. The Association of American Universities has gone into this question very thoroughly during the past two years and while I do not have time to go into it in detail, I should like to read you one paragraph from their recent report:

"The intellectual discipline and the exacting performances called for in the Ph.D. degree program at its best would seem to be more needed today than ever before. A candidate for this degree improves his scholarly capacity through original investigations even though the results of his work may not be published. The experience gained in selecting and carrying out a piece of research has inestimable value for the student preparing for an intellectual career, whether as a research scientist, a worker in the social field, or a college teacher. Certainly the preparation for the teaching of advanced subjects depend directly upon capacity acquired in research training and generally upon the thoroughness with which the research is done. To sacrifice these in any measure would result in a major loss and would not be justified even if done in the interest of so worthy an undertaking as the attempted improvement of college instruction."

This does not mean that every effort should not be made to train most of our research workers for teaching as well as for research. But, in so doing we need only to return to President Gilman's statement and quote "... his ability to express in clear and systematic order, and in appropriate language, the results of his study."

(4) Since project research in universities, with close relationship to gradu-

ate training, has been so successful and productive, industry has become very interested in the program. In 1946 a total of 302 companies reported to the National Research Council that they were supporting research outside their own laboratories through approximately 1800 fellowships, scholarships and grants. This support is of two general types: (1) the financing of specific projects of immediate interest and benefit to the sponsors and (2) unrestricted gifts without expectation of any direct return to the sponsors in order to aid in the adequate training of scientific personnel and to foster fundamental research. There can be no objection to industry giving support to universities so that they can more efficiently perform their function of training men, expanding the frontiers of knowledge, stimulating the spirit of inquiry on the part of both faculty and students and providing proper atmosphere and facilities for work. In fact, industry has some obligation in underwriting this type of support. It should be closely correlated with similar support from the government. However, there may be times when industry may take advantage of university research facilities to solve some of their specific problems. As funds for research become more limited, competition for such funds may be greater. However, universities should not be turned into industrial research laboratories or commercial testing agencies. I believe I can truthfully say that all the grants accepted by the University of Wisconsin are for the support of basic research and the results can be published freely. As long as such arrangements hold, the graduate student should have no worries and we should have no serious problems in the future.

(5) There is no question but what the present program makes more work for the professor. Link says our program gives the graduate students ulcers. I believe the professor has more right to expect the ulcers. Even the National Institute of Health program which was set up to support research in medicine and related fields and made definite attempts to minimize the amount of red-tape necessary to get these grants, requires an annual report and a renewal application each year. For that matter, those who receive aid



from the Research Committee of the Graduate School must write up a report each year. Unfortunately, I have to read a lot of both types of reports. So, if the professor doesn't have more work to do, at least the secretary must do it. In this connection I cannot help but quote from a report recently written by L. F. Fieser of Harvard University on his *Impressions of Chemistry on the European Continent*:

"In European universities there also seems to be a better appreciation of the kind of life the head of a substantial research group leads. If a professor not only has the usual allotment of lecturing, advising, and recommending assignments and does his share of administrative and committee work, but also has to try to see 15 to 20 research people nearly every day, keep them supplied with problems, write 10 to 20 papers a year and perhaps a review article or two, maintain industrial contacts and find jobs for his men, answer a voluminous mail, accept a part of the invitations to give lectures, and perhaps squeeze in some experimentation with his own hands—then he is not just another professor of the faculty but one who can meet his many obligations only by fighting a constant battle against time. I know of no university here or abroad where a solution of this problem has been found that satisfies all interests concerned, but I think that the problem is much better understood in Europe than it is here and that European universities provide their professors who are active in chemical research with far more adequate administrative, professional, technical and secretarial assistance than do ours. Most Americans would be content with something far less than the continental professorships that even provide the incumbent with a fine residence."

(6) While we have heard the statement that the deficit in the number of individuals receiving an advanced degree in science will amount to 17,000 by 1955, we are now finding that our training program is supplying the requirement more rapidly than we had anticipated. Inevitably, we will reach again an oversupply of trained individuals. Regardless of the importance of research, a limit will ultimately be

reached and further research cannot be supported by this country. This will mean that we will have to practice greater efficiency in the field of research as well as in other fields. How serious this problem will become I do not know, but as long as research programs are continued in our universities more Ph.D.'s will be trained. The more pessimistic thinkers, especially Howard Mumford Jones, point out that Ph.D.'s without jobs become embittered men. The unemployed intellectual is a social menace. He calls these baffling confusions of graduate education. Some fields will be hit harder than others. These problems are already being discussed in the medical field where we have seen rapid increases for the support of research fellowships. Why train these capable young men if they have no permanent positions to look forward to? In medicine they may go into general practice rather than research but certainly they will be lost to the field of research. The John and Mary Markle Foundation has made some attempt to cope with this problem.

I have raised six important questions which we cannot settle tonight but I would like to end with a more optimistic note. Certainly our graduate students who come in contact with practical problems proposed by industry, medicine and even politicians will have a broader outlook in the future than those who come in contact only with theoretical questions proposed by the professor and in this connection I would like to close with a quotation from a talk made by David M. DeLo of the Department of the Army, "Science and the Nation's Future."

"It seems inescapable that organized science in the United States must assume new and grave responsibilities. In a democratic society, constantly subjected to variable internal and external pressures, it should form a stable and consistent core from which sound scientific advice and information will constantly emanate. Research must progress as rapidly as personnel and funds permit. Beyond this, scientists must do everything in their power to make sure that the applications of science strengthen every facet of national life and that we build soundly for our nation's future."

# IS IT A MALE? \*

By PROF. DAVID CAUSEY, PH.D. †

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During those seven long years that Darwin labored at his barnacles and produced the monographs on the living and fossil Cirripedia which made him an authority on barnacles and so competent to speak finally on all things, his growing children, steeped in an environment of sessile and smelly crustaceans, believed that all men worked on barnacles. In my house it is millipedes!

I have nothing against millipedes *per se*. There are times when even I can see a spot of beauty in their color, the pattern of the color, and/or their form. While some smell like something long dead, but not buried, others have a pleasant smell of camphor, and in some the cyanide odor makes me nostalgic for those undergraduate days when I still knew the difference between an acid and a base. In my favorite armchair, digesting a good meal and smoking a better pipe, I can even speak kindly of them—that is, if I haven't been out collecting them. All in all, I can take them or leave them.

Have you ever collected millipedes? You probably don't know what they are. The only one I used to know was the common house millipede, and that is a centipede! They are smallish, leggy creatures (something like the front row in a class room), quietly playing their little hours upon the stage until you come along and collect them. You can get all the thrills of collecting them in your own home. There is only one way to collect them—the hard way. Kneel down on the floor, upon your hands and knees. I won't insist that there be a briar under your left knee

and a small sharp stone under the right one, but there would be in the field. Try to rip off a piece of the baseboard with your fingers, breaking at least one finger nail. That's rolling over a log or overturning a stone. Now, on your hands and knees, crawl and scratch at the floor for a couple of hours. Don't mind an occasional splinter, that's merely a centipede bite and will be forgotten with the next one. You are working through the leaf litter and the superficial soil. Now and then some one ought to drag a length of wet rubber tubing across your hand—that's a snake you don't have time to look at. Every few moments you are to bend over and look intently at something on the floor, occasionally with a hand lens, or pick up a something with forceps and put it in a vial. You carry vials in your left hand, forceps in your right. That leaves only three hands to swat flies and mosquitoes, wipe the sweat from your forehead, and loosen berry canes.

Few animals have travelled as far on their hands and knees and seen less than I have. I've spent weeks in the Great Smokies on my knees and while I know that its leaf litter is thick and insecty and that the moss grows luxuriantly on the fallen logs, I still don't know what the Smokies look like—all I've had is a sort of dog-burying-a-bone view of them. If you should see vast areas of the southern landscape disturbed and disordered, the litter shifted, the logs heaved, and the stones out of place—not Kilroy, but Causey has been there.

There are millipedes and millipedes. The immediate need varies according to some mysterious taxonomic barometer along which are strung millipede genera and species instead of milli-

\* Retiring presidential address, The Southern Academy of Hysterical Science.

† Dr. Nell Bevel Causey's husband.



meters. Sometimes it is the big ones and you wonder if some sort of grabbing device or the park paper gatherer's nail in a stick wouldn't save you a few squats. You come in with a fairish collection—a few dozen odds and ends, including some insect larvae you hope will get millipede credit. Maybe, if you've been lucky you have a few hundred. You proudly say that you have some new ones. Actually you don't know one from another and you, personally, classify them by size, smell, and profanity. She chucks your most promising in the preservative with contempt (temporarily they are just the ordinary common ones—temporarily, I say). Then some miserable, shop-worn specimen which fell into your vial by mistake or carelessness (you really suspected it was a beetle larva) is seized upon with feminine squeals of joy. "It's a new one!" She gets out her hand lens. "Is it a male?" And then comes that indelicate investigation while you stand there and your poor old heart practically stops ticking and your battered knees tremble. She unrolls it and peeks (millipedes have no privacy these days, and males have gonopods). A gonopod is an impressionistic toothpick which has nothing to do with teeth. Her face falls. Of course it's a female, it's new, and it's important. Back to the salt mines—I mean, back to the leaf litter and the logs. A few more acres and maybe you'll find a male. So far as I know, a male is just something which grows gonopods. Occasionally it is a male, alone in all his glory. God's in the heavens and all's right with the world? Not at all. Once the thrill that it is a male (upon which species are based) passes, she remembers that there are two sexes. "I just have to have a female." You didn't get a female, and while you wonder what difference it makes to a male dunked in 70% alcohol whether or not he has a mate, she thinks it does, and back to the leaf litter you go.

The common ones—those which she puts in the preservative with a rabid twitch of her nose—she just wasn't working on them then. They, too, have their day. There comes a time, maybe in the winter when you are working through the garden seed

catalogs or the fishing tackle offerings, and she gets around to them. She's preparing a monograph on the millipedes of the universe, with footnotes on all other places. So, she works through the common ones again. Group after group—today they are genera, tomorrow maybe families, as a taxonomic fortunes rise and fall. She finds an extra bristle on the third joint of the 15th left leg, or under the electron microscope a molecule in the stern end has a warped appearance. The old genus has to be divided and she needs more specimens. You might just as well forget that come summer you intended to fish in the Wisconsin lakes or go to the seashore just to see. You're going back after more of those uncommon common ones.

You try various implements for messing up the earth's fair face. Thus far I've tried an army trenching tool, a geologist's pick, a garden hand cultivator, a hunting knife, a limey's knife which has a marlin-spike on it, and such improvised items as sticks and toes. Best of all is one's fingers, but after a couple of hours the bones begin to protrude and you get to worrying. Just now I'm using three times from a broken garden rake fitted to a handle. It works well, and I've considered marketing them for collectors, but I don't know where I'd be able to get enough broken rakes.

About the time you think that you've experienced all the griefs and miseries of millipede collecting, an opinion shared by your knees and back, she springs the oniscoids upon you. If you can see them, they look something like pillbugs or sowbugs, or whatever you are accustomed to call them.\* Now these isopods can be picked up with the fingers. The oniscoids, however, are practically invisible, and I'd like to meet the man who first discovered them. An oniscoid  $\frac{1}{4}$  of an inch long is a giant, most of them are small, while many are runts. They occur in the lowermost leaves and the topmost grains of soil, and generally about one

\* Mother sewed a few of them in a cloth sack, which was hung around my neck when I was a child. They prevented seasickness or falling fits, or something. This has nothing to do with millipedes, but footnotes impress the dean as scholarly.

to the acre. The mess along the sides of a rotting log is good hunting ground, especially if the briars are doing well (poison ivy helps, too!) You get down, and I mean down, and you slowly shift the material grain after grain. I've gone miles that way—in the prone position. And I've found some of them. Once I found two in the same afternoon, and the constable thought I'd been drinking!

You've guessed it—there are many kinds of oniscoids. Each impenetrable and inaccessible mountain side has its own species or she will make them so. Why not—you can't see them anyway! And when you find one—well, here we go again. It is all rolled up, like a tire off a fairy's tricycle. You wait patiently, you can't unroll it, might hurt the delicate little thing—and when it stretches out she looks with a hand lens, holding her breath. "Is it a male?" you dumbly ask. It isn't. And the poor little delicate thing goes into the alcohol, and you go back to the hills after its invisible mate.

There's an indoor phase to this activity. We can't get everywhere to collect. A systematist (that's a taxonomist living on the right side of the track) needs specimens from everywhere and points in between. Now I know a lot of people—zoologists, queer, of course, but kindly and I hope, good natured. She will look up from Better Shacks andhovels (she has her lighter moments) and suddenly say, "I need some millipedes from .....," Maybe, like Abe Lincoln,† I'll think of someone I've slept with. Fine, I'll ask the poor soul to go hunt millipedes. And I've asked people I might have slept with, people I wouldn't and people who wouldn't. I've asked people all over the United States. Some will, and some won't.

Brother (or sister), have you got time to collect a few millipedes for my wife?

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† A. A. Woldman, in the May, 1950, *Harper's* implies Lincoln never said anything. I can vouch for the sleeping story, I heard him tell it.



## Tremendous Power in the University

The university is truly a rock for the society of free men. It is such a rock because it is an institution which is intensively pre-occupied with the activities of the human mind.

Thus arises the tremendous power lodged in the university. The greatest power in the world today is not the atom bomb. The human mind that conceived the bomb is a greater power by far. We do not have to fear that power when it operates in an environment of freedom. We have everything to fear when it is curbed and perverted.

In a broad sense, our civilization is the fruit of the university, of a traditional approach to knowledge that is humane and responsible because it cultivates the spirit along with the intellect.

If we have taken this tradition for granted, now is the time to reassess it.

For if, at the same hour that men succeed in splitting the atom, they allow the intellect to be divided from

the conscience, all the achievements of science, the contributions to the world's wealth and to man's comfort, the engineering wonders, and the medical advances, are but a handful of dust.

We must not let this happen.

Higher education in America must adhere to its humane tradition, seek the truth, and aid men and women to develop the enlightened intellect, broad human sympathies, and responsible character.

The indispensable condition for this job is freedom. We must continue to maintain universities which can resist political pressure or pressure from organized groups or vested interests.

We must do this or fall victims to the tragic failure that we have already seen demonstrated in our time: the failure to see that it is the enlightenment of the spirit, not the dictates of legislation, that makes men free—Inaugural Address, President James Roscoe Miller, Northwestern University.



# GOETHE AS A BIOLOGIST

By HARLEY H. BARTLETT\*

*Goethe's Recognized Position as a Pioneer in Biology  
Will Come to Many as a Surprise*

Goethe's activities in science were, in his own estimation, quite as important as those in literature. Nevertheless his significance as a scientist is singularly difficult to appraise. It has been a subject of debate ever since his own time, and is likely to continue to be so for generations to come, for so long as he holds his place as a great poet whatever forces directed or restrained his poetic imagination will continue to be of interest. There can be no doubt that Goethe's scientific work largely determined his own mental development, and therefore influenced the course of German literature. The growth of his scientific interests paralleled his increasing dissatisfaction with the *Sturm Und Drang* period for which he himself

was responsible. Whether he then became the poet of evolution, as many have contended he did, depends upon one's interpretation of what he meant by metamorphosis. In accordance with the answer, some will insist, depends his place in the history of science. He will emerge as a forerunner of evolution, a pre-Darwinian, or as the founder of the futile nature philosophy which in the person of Oken, Goethe's imitator, ran amok in Goethe's own time.

I do not recognize that there are only these alternatives. Many of Goethe's contemporaries hold an honorable place as scientists who were not evolutionists. If it is quite impossible to allow Goethe a place with Lamarck, Buffon, and Erasmus Darwin as precursors of the founder of evolution, would it add greatly to his luster to be placed among some twenty or thirty lesser lights?

Goethe developed his ideas in such obscurity that there has been endless argument about what they implied. Oken, the German naturalist and philosopher (1779-1851), may be held to have merely followed where Goethe led, and to have supplied perhaps the one possible logical working out of his ideas. Yet J. Arthur Thomson held that Goethe was the greatest poet of evolution, but that Oken so jumbled sense and nonsense that he could be regarded as a farseeing prophet or as a fatuous follower of intellectual will-o'-the-wisps.

An English student of Goethe, Professor J. G. Robertson, concluded that Goethe's scientific studies and discoveries now possess only a historical interest. Robertson said:

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\* Professor Bartlett, A.B. *cum laude* in chemistry, Harvard, 1908, spent some years as a chemical biologist in the U. S. Department of Agriculture, came to the University of Michigan in 1915 as Assistant Professor of Botany, was appointed to a professorship in 1921, and later served as head of the Department. He has made botanical studies and surveys in the East Indies and Latin America and has also interested himself in the ethnology of Sumatra, Formosa, and the Philippines. In 1935 he was an exchange professor at the University of the Philippines and during the war a rubber expert for the U. S. Department of Agriculture. He is an ex-president of the Botanical Society of America; the Michigan Academy of Sciences, Arts, and Letters; and the Research Club of the University. He is a member of the American Philosophical Society. His previous contributions to the *QUARTERLY* include "Vernacular Literature in the Philippines" (Summer, 1936), "Asa Gray's Nonresident Professorship" (Spring, 1941), and "The Botanical Garden at the University of Michigan" (Winter, 1943). This article is reprinted by courtesy of the *QUARTERLY REVIEW* of the Michigan Alumnus, Summer issue, 1949.

Of real importance was his foreshadowing of the Darwinian theory in his works on the metamorphosis of plants and on biological morphology.



GOETHE, POET AND BIOLOGIST

*From a portrait painted in 1819  
by George Dawe*

Indeed, the deduction to be drawn from Goethe's contributions to botany and anatomy is that he, as few of his contemporaries, possessed that type of scientific mind which, in the 19th century, has made for progress; he was Darwin's predecessor by virtue of his enunciation of what has now become one of the commonplaces of natural science—organic evolution.

It is hard to grant that one could be greatly concerned with the problems of organic evolution, or even envisage them clearly, who was not concerned with the basic problem of the origin of species. I have sought diligently for any pronouncement on this subject from Goethe, and the only statement that I find is surely an amazing one. Written in 1823, thirty-three years after the publication of the doctrine of metamorphosis, it indicates neither belief in change of species nor in constancy. It holds out, to be sure,

a strong hint that hybridity or promiscuity causes variability within species, but that is all. He wrote:

Natural System: a contradictory conception. Nature has no system; she has, she is, life and continuity out of an unknown center, to an unknowable boundary. The idea of metamorphosis is a highly venerated but at the same time highly terrifying gift from above. It leads into formlessness, destroys knowledge,—dissolves it. It is like centrifugal force, and would lose itself in endlessness if there were not a counterbalance for it: I allude to the impulse for specificity, the tenacious capacity for constancy of that which once comes into being, a centripetal force, which basically can take on nothing external to itself. One may consider the genus *Erica*.

If I consider those things that one calls genera in botany, and those which are held to be such as they have been set up, so I must always conclude that one genus is not to be handled in the same way as another. There are genera, I may say, that have character, in that they manifest themselves again in all their species, so that one can approach them in a rational way. They do not easily lose themselves in varieties, for which reason they can be handled with confidence. I mention the gentians: the critical botanist will be able to characterize a number of them.

On the contrary there are characterless genera, to which one can hardly ascribe species, because these lose themselves in indefinable varieties. If one handles these in scientific earnest, one will never be through, indeed one becomes ever more confused by them, since they evade every determination, every law. These genera I have often allowed myself to call the profligate ones and to bestow this epithet upon the roses, by which their charm is not diminished. Especially may *Rosa canina* invite this reproach.

By way of contrast with Robertson's conclusion, Hirsch, a German contributor to the *Annalen der Naturphilosophie* in 1912, went over all the evidence for classifying Goethe as an evolutionist and concluded: "Goethe is no founder of today's doctrine of descent. He was, however, a distinguished promoter of ideas that led to it and of



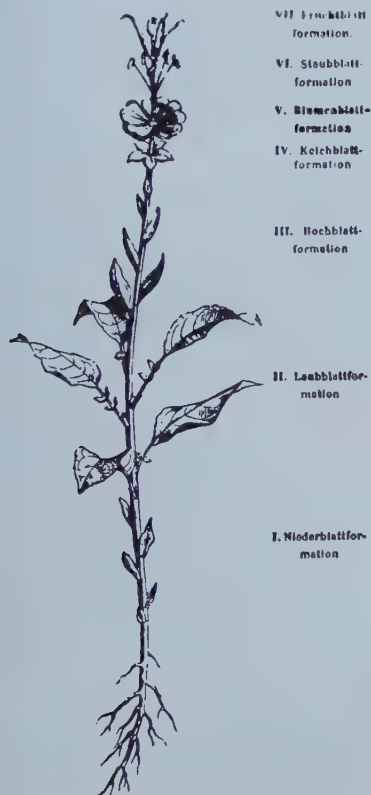
the investigation upon which it was based."

Going back through some small part of the enormous literature on Goethe, I find that scientists in general agree with the latter conclusion. Others, mostly not scientists but including very distinguished names in science, take the other side. A select bibliography of the subject would include at least a hundred titles, and a reasonably comprehensive bibliography several times that many, for authors who have written about Goethe are legion.

If Ernst Haeckel, the first and most enthusiastic apostle of Darwinism in Germany, did not actually originate the tradition that Goethe was the poet of evolution, he certainly did much to disseminate it. Only seven years after the publication of Darwin's *Origin of Species*, Haeckel called attention in his

*General Morphology* to theses of Goethe which he thought might be considered as "phyletic prophecies," and which led him to consider Goethe as a precursor of Darwin.

In the field of comparative anatomy Goethe did two things that impressed Haeckel. First, he rediscovered the intermaxillary bone in man. Secondly, he proposed a theory that the skull was made up of modified vertebrae. As we shall see, each of these contributions was applicable to a theory of evolution and, even if Goethe drew no genetic evolutionary conclusions, Haeckel did it for him. Indeed, after Darwin's masterly exposition of evolution, it was almost impossible for any scientist who accepted the theory of evolution not to imagine evolutionary thinking on the part of any thoroughgoing advocate of the comparative method in zoology or botany. So far as most biologists were concerned, *Naturphilos-*



GOETHE'S TYPE PLANT

*Illustrating his concept of the metamorphosis of plants and the correspondence, as interpreted by later botanists, of leaves and flower parts.*

ophie died so completely in the period between Cuvier's onslaught upon it in 1831 and the coming of the Darwinian idea of evolution that obviously it was hardly possible for the new generation of biologists, to which Haeckel belonged, to grasp its conceptions. Haeckel, finding in Goethe little of the grotesque absurdity of such a nature philosopher as Oken, and admiring Goethe's poetic genius, seems to have found it impossible not to interpret the doctrine of metamorphosis as evolutionary, involving geological time and implying genetic relationships among living beings.

To Goethe's contemporaries in *Naturphilosophie*, however, and, I believe, to Goethe himself, "metamorphosis" meant nothing of the sort. It was merely the expression of an idea that animals or plants were constructed according to a definite plan, which plan was subject to infinite variation, but involved neither geological time nor relationship by descent, and was not inconsistent with the doctrine of special creation.

Before entering upon any biographical delving into the origin of Goethe's doctrine, it will be well to try to state what he meant by metamorphosis. In essence it is that the lateral organs of any plant are constructed according to a definite plan and may be regarded as modified leaves. Correspondingly, different plants are but variations of the same architectural plan. Animals, according to his theory, are composed of repeated parts corresponding to the vertebrae of the spinal column. One could therefore conceive of a type plant, and of a type animal, of which all others could be interpreted as variations. If this is not an exactly correct statement of Goethe's idea, it is surely the idea that he allowed to grow out of his, without contradiction.

Goethe's first active interest in science was aroused by Lavater, the amiable German pastor and mystical poet who wrote voluminously but is remembered chiefly by his discursive, harmless book on a subject, physiognomy, which had had an unfortunate association through the ages with such reprehensible pursuits as astrology, magic, and divination. Goethe sought to collaborate with Lavater by demonstrat-

ing an anatomical basis for physiognomy and in the little poem "Typus" declared that "There is nothing in the skin that is not in the bones." This idea seems to explain Goethe's inordinate preoccupation with bones, which in his imitator Oken, grew into a regular "bone philosophy." Goethe's active association with Lavater from 1774 to 1783 covered the period from 1775 to 1778 when Lavater's book was in course of publication. Goethe anonymously contributed much to Lavater's book. He had the manuscript and illustrations with him at Frankfurt and Weimar, with permission to make such revision as he wished. Eckermann quoted Goethe as having said that all that Lavater's book contained about animal skulls was Goethe's.

The two were then on terms of the most cordial friendship, and even when this cooled to the point where relations were strained and broken, apparently because Goethe felt that Lavater's mysticism had degenerated into superstition, he gratefully acknowledged in his autobiography that Lavater had exercised a very stimulating influence upon him.

After the French campaign of 1792 Goethe visited Münster and was asked by friends there to account for his interest in physiognomy and osteology, the latter seeming so very inappropriate in a poet. He replied that just as he had been led into the study of anatomy in his academic years through the influence of Lavater's physiognomy, so it was the same influence that had led him back to it.

So Goethe's study of comparative anatomy started with fanciful physiognomy, but led to the theory of the "type animal" and the doctrine of metamorphosis. It began a little earlier than his botanical work, but was carried on at the same time. His principal achievement was the rediscovery of the intermaxillary bone in man and his appreciation of its importance in adding to the proof of man's basic structural identity with the other mammals. Except for the accident of not procuring publication for this discovery of 1784, for which manuscript was certainly ready as early as 1786, it would have been his first published scientific work.



Just why finding the vestigial premaxillary (intermaxillary) bone in man should have been deemed so important goes back to the belief, current in Goethe's time, that the lack of this bone was distinctive of man and distinguishing him from the apes. To find it in man afforded an indication that if this minor anatomical distinction did not exist, there was every likelihood of complete homology between man and lower mammals.

The existence of the premaxillary bone is often ignored by practical anatomists. A modern statement is that the premaxilla of the mammals bears the incisor teeth "and *except in man* the suture between it and the maxilla is evident on the face if a young enough animal be looked at." In the course of development of the embryo one or two centers of ossification develop into the premaxilla and afford sockets for the incisor teeth. The suture delimiting the premaxilla in frontal aspect disappears before birth, but a trace of it remains visible in many skulls in palatal aspect. If the premaxillary sutures fail to unite, the condition known as cleft palate results.

In 1819 Goethe wrote that he had been anticipated in the sixteenth century by Vesalius, who figured the intermaxillary suture in palatal view but not in front view of an adult skull. He also found that in the eighteenth century Albinus of Leyden, the teacher of Haller, discovered the premaxillary in the human foetus, indicated by a suture in both front and palatal aspects. Goethe was anticipated by several others, among them, according to Cole, by Vicq d'Azyr, who described it in the human foetus in 1780.

In Goethe's time several of the current handbooks of anatomy for students of medicine gave no indication of the premaxillary bone, and it has been assumed that at first he did not look more deeply into the subject.

When Goethe made his observations, an account of them was translated into Latin by the anatomist Loder and sent to Pieter Camper of Amsterdam, then the leading human anatomist, for publication. Camper, unable to verify presence of the suture in adult skulls of Negroes, Hottentots, Kalmucks,

Chinese, and in newborn and unborn European infants, decided that Goethe's observations were wrong. Camper is presumed to have examined only the frontal aspect of the skulls, for in such abundant material as his there would surely have been some specimens with the suture showing in the palatal aspect. (Thomas Kalliker, a later investigator, found that 96 out of 325 skulls showed the intermaxillary suture in palatal view but not one of them gave any indication of it in front view.)

Except for a note by Loder in his *Anatomical Handbook*, Goethe failed to get any prompt publicity for his discovery, but his letters from 1784 to 1786 and later have enthusiastic references to his "little bone," the lack of which in man had been the supposed crucial distinction between man and the apes. Even if he made no prompt formal publication under his own authorship, his discovery went far and wide by letter, and Goethe delayed full publication until 1817.

We may now turn to the second of Goethe's contributions to vertebrate anatomy, the theory of the vertebral



SKETCH BY GOETHE  
Illustrating his studies of the premaxillary bone in various mammals

structure of the skull. He explained all the skull bones, including the facial, as derived from vertebrae. The homologies which he thought he established proved not to be real, although his theory has been credited with preparing the minds of morphologists for a more modern substitute for it which is in good standing. Untenable as his conclusions proved to be in the long run, credit for them was disputed by Oken in 1807, a decade before Goethe got around to doing more than talking and writing to his friends. Goethe arrived at his theory during his Italian journey, in 1784 or immediately thereafter.

In 1815 Goethe made the outright accusation that Oken had stolen the idea from him. Oken, however, went far beyond Goethe's views in his inaugural dissertation on the occasion of entering upon a professorship at the University of Jena. It was entitled "On the Meaning of the Skull Bones" and developed a fantastic extension of Goethe's theory, namely, that the whole skeleton was only a branched spine—that the whole man, or other animal, was only a backbone or a secondary consequence of his backbone. Even this grotesque conception, Oken's "bone philosophy," as he called it, has been kindly regarded by good-natured followers and regarded as a useful precursor of the concepts that later developed from the discovery of the chorda dorsalis. Oken published and Goethe didn't.

Relations between Goethe, Curator of the University of Jena, and Professor Oken were strained, and the latter attributed certain misfortunes of his career at Weimar and Jena to the former, although recognizing Goethe's superiority to himself. Oken imitated Goethe and developed the same theories, always with more extravagant applications than Goethe would have made.

It cannot be said that the priority dispute between Goethe and Oken was ever decided, and one may perhaps be satisfied to think that each honestly believed that he independently originated the vertebral theory of the skull. The theory was used by both in developing their conceptions of morphology and was passed on to other naturalists and nature philosophers. Goethe considered it essential to his concept of

morphology, for just as he postulated a type plant and a type animal, so there had to be a type unit-structure of each to undergo variation, in the plant the leaf, and in the animal the vertebra, with whatever else went with it.

These were the biological or morphological concepts that Goethe thought would unify all thinking about living things. His ideas of metamorphosis as they applied to plants were published with reasonable promptness after his return from the Italian journey.

Most of Goethe's own contemporaries seemed to believe that his first and, as it proved, most cordially received, contribution to science, the doctrine of metamorphosis in plants, resulted from a sudden flash of inspiration for which he presented such argument or evidence as he would hastily adduce. This idea early became part of the body of Goethe tradition and has had currency down to the present time. Goethe encouraged or at least tolerated it, and then in his old age vigorously denied it, but by his own testimony it was not far from true.

In 1831, only a year before his death, he wrote that for more than half a century he had been known in the Fatherland and abroad as a poet, and as a matter of convenience, had let himself be classified that way. It was not generally realized that he had devoted greater attention to natural science than to poetry, having studied both the general physical and the organic manifestations of nature, and that he had quietly, consistently, and painstakingly carried out carefully planned observations. As his essay designed to explain the metamorphosis of plants, published over forty years before, was now receiving greater recognition, especially in Switzerland and France, he finally deemed it proper to deny the prevailing misconception that his idea had come to him unexpectedly as a sudden inspiration. There had been much wonder about how a poet could turn from the path of his proper concerns and in a fleeting detour, as it were, make a significant scientific discovery. Although he had felt flattered at having such a reputation for sagacity, and had allowed a false conception to become current, the fact was that his



fortunate idea of metamorphosis had been arrived at by straight-forward effort.

Goethe tells how his botanical self-education at Weimar had paralleled somewhat the history of botany itself. Beginning presumably in 1776, his practical interests at first might have been likened to those of the ancient Greek *rhizotomoi*, who gathered roots for medicine. Dr. Buchholz, the able local apothecary at Weimar, was interested in both the old and the new, was a chemist as well as a botanist. He had a mission to expound science, and Goethe listened. Buchholz had drug plants in his own little garden, but also grew whatever other plants he could get that were new and interesting. His efforts, seconded by Goethe's, resulted in a genuine botanical gardening enterprise with support of the court.

Goethe had his own garden too, and his enthusiasm was infectious, so that soon there was a wide circle of amateur botanists at Weimar. It may have been Buchholz who introduced Goethe to several works of Linnaeus, among them the *Fundamenta Botanica*, upon which botanical science seemed to Goethe to be soundly based, and also to Gesner's *Dissertationes*, which elucidated certain Linnaean doctrines. Linnaeus' *Philosophia Botanica* was his daily study, literally his vade mecum. At neighboring Jena he profited from the advice of the professors and became familiar with the long-antiquated *Flora Jenensis* of Rupp, which sufficed for identification of the plants of the region under their pre-Linnaean names.

In Ziegenhain, Goethe made the acquaintance of the Dietrich family. Old farmer Dietrich, founder of a botanical clan, had felt that he held a patent of nobility in botany because he had attracted the favorable attention of Linnaeus and once received a letter from that great man. His son carried on the tradition of being local authority on medicinal plants for the commercial herb gatherers, the botanical dilettanti, the medical students, and the community at large. His influence reached Weimar. A nephew, Friedrich Gottlieb Dietrich, became the friend and botanizing companion of Goethe, ultimately at-

tained the doctorate, became a botanical author, and had charge of the Grand Duke's garden in Eisenach.

Goethe likewise acknowledged how much he owed to August Karl Batsch, whose ambition was to perfect a system of classifying plants in families in a sequence from the less to the more highly developed. This method, which had been advocated by Linnaeus but carried forward only by Jussieu in France, then greatly appealed to Goethe, so it seems very inconsistent that he was later (1823) to say that there was not and could not be system in nature.

It is quite clear that prior to 1790 Goethe had been a very enthusiastic botanical amateur, but had little formal preparation for technical authorship, and would probably not have known it if others had anticipated him in interpreting the phenomena, well known to many, upon which he based his theory of metamorphosis. Perhaps to guard against possible criticism on this score, he said in the *Metamorphosis*:

The underlying kinship of the various external members of the plant, such as the leaves, calyx, corolla, and stamens, which develop one after another and, as it were, from one another, has long been recognized by naturalists in a general way; it has indeed received special attention, and the process by which one and the same organ presents itself to our eyes under protean forms, has been called the "Metamorphosis of Plants."

Incredible as it may seem, up to the time of becoming a botanist by virtue of publishing his book, Goethe seems to have lived almost apart from the botanical past except for inseparable companionship with some of the works of Linnaeus. The authors who had influenced his intellectual development most, he said, were Shakespeare and Spinoza; and after them no one more than Linnaeus. It has dismayed a modern botanist, Agnes Arber, who has written an admirable essay on *Goethe's Botany*, and who evidently has a low opinion of Linnaeus, which I hope is not generally shared, to find him mentioned by Goethe in the same breath with Shakespeare and Spinoza. She explains what she fears may be inter-

puted as lack on Goethe's part of discrimination between great and near great by saying that his words do not relate to these three men in general but only in their effect upon his own personal development, an effect depending largely upon his individual circumstances!

In Goethe's original work of 1790 there was no reference by name to his predecessor Wolff, or, indeed, to any other author except Linnaeus, although there are indirect allusions to others. He should at least have known of Nehemiah Grew, who published similar ideas in 1672, and of Malpighi. It was not until 1817 that Goethe told of his discovery that he had had a forerunner in Kaspar Friedrich Wolff. It appears that Goethe published a request for information about anyone who may have anticipated his announcement of the idea of metamorphosis. He was informed by a cousin of Wolff that the latter, a German scientist at St. Petersburg, had published a very clear statement of the idea in 1768. Goethe referred to it with the comment "We are original because we know nothing." He certainly conceived his own idea in such scientific isolation and with so scanty a background of botanical reading that it must have been original with him.

The evidence of Goethe's wide reading has been published in the record of books withdrawn by him from Weimar library over the course of fifty-six years. In later life they were amazingly diversified, including the important literature of the time in many fields, but he used few books of science before 1790 and none that could have influenced the writing of the *Metamorphosis*. Of course he had his own books also, and access to those at Jena; likewise association with Buchholz must have influenced him. There were no botanists among his correspondents until later.

Many comments have been made about scientific deficiencies of Goethe's book, and about its peculiar literary form. It made no application of his theory to any plants except annual herbs. Yet the inspiration for it came, he said, from his contemplation of a palm in the botanical garden of Padua, where there is still a specimen that is

pointed out as the one. He wrote that according to the model of this wonderful type plant he could conceive of new plants forever, all variations of the one, and that the same law would apply to all living things. Nevertheless he never mentioned the palm in his book of 1790, although he was to say that the moment when he realized what it signified was the most glorious moment of his life. "To conceive, to sustain such an idea, to discern it in Nature, is a task which transports one into a region of tormented bliss."

Oken showed no such limitations. Where Goethe beckoned, he followed. Many botanists have commented upon Goethe's complete disregard of the cryptogams, and of his skirting completely around the problem presented by parts of the plant that were not equivalent of, or associated with, the leaf. Oken did not hesitate to take Goethe's type plant apart, and to populate the world with the descendants of the pieces, which were autonomous but imperfect organisms with affinity to the soil (if they came from the root of a terrestrial plant), or with affinity to the water, or to the air. His flights of fancy knew no such restraint as Goethe's, but he got the idea of it from Goethe's notion that a detached runner of a strawberry plant would remain a runner forevermore. What boundless possibilities might there be if all parts of all plants could thus run their courses in nature and each undergo its own metamorphoses!

When questioned about his neglect of the root, Goethe said that it need not concern him because it showed no impulse toward perfection! It has been conjectured that the subject matter limitation of the *Metamorphosis* may have resulted from hasty publication occasioned by the fear that someone else would publish first and get credit for the theory. It is my belief, rather, that Goethe was content to give illustrations of how his all-inclusive conception of unity in nature was borne out by a particular category of plants, namely, annual herbs. A complete application to all plants he did not consider necessary; others could carry on from where he left off.

Gunther Schmid has suggested that Goethe thought he was about to be an-



ticipated by another German amateur botanist, the classical philologist Christian Konrad Sprengel, who, in 1789 announced that in the following year he would publish a book entitled "Attempt to Explain the Construction of Flowers." Goethe rushed into print with his *Attempt to Explain the Metamorphosis of Plants*. The similarity of the titles is remarkable. Sprengel's work (*Das entdeckte Geheimnis der Natur im Bau und in der Befruchtung der Blumen*, Berlin, 1793) did not, as a matter of fact, appear until three years after the announcement, and then, falling dead from the press, hardly received any recognition at all until Darwin repeatedly called attention to its originality and value some seventy years later. Thereupon it became recognized as one of the classics of natural history. Goethe need not have been disturbed (if he was) by its coming, for it dealt with the adaptations of flower form to insect pollination.

Goethe's little book, however, was cast in a very peculiar literary form, not adapted to a sustained argument or development, a fact which is only explained by its having been modeled after a work that he greatly admired. Among the botanical books that he knew best was the *Fundamenta Botanica* of Linnaeus, which consists of 365 numbered aphorisms.

Goethe did not follow his literary model too closely, for there are some of his numbered paragraphs which are hardly aphorisms. Nevertheless, the work is too greatly condensed to allow for complete development of the theory or for reasonably convincing presentation of evidence. Its conceptions of plant anatomy and of the nature of solutions were already antiquated at the time of first publication in 1790, and became increasingly so when the book was republished without revision in 1817 and 1831. It seems that its anachronisms must have created an unfavorable impression. Nevertheless it presented the germ of an important idea, even if only the germ, for because of willingness of his followers to read into his work more than is actually there, Goethe has eventually come to receive more credit than he strictly deserved.

The deficiencies of Goethe's own presentation of the doctrine of metamorphosis invited its amplification by others, so that second- and third-hand accounts sometimes credit Goethe with the idea of a more definite type plant, or *Urpflanze*, than he conceived, even one that was ancestral in an evolutionary sense, for Goethe had no clear idea of relationship by descent, although it is possible to read interpretations into his work which would certainly have surprised him.

There are passages in Goethe, in fact, which to the mystically inclined will sometime be held to be premonitions of modern ideas about formative substances and hormones, and a ponderous monograph on the matter will surely be forthcoming in due time. It has already had its own premonitions. As far as Goethe's "type plant" is concerned, if he did not like the way others developed the concept he had only himself to blame, for he did not bother to express either satisfaction or dissatisfaction. His chief contemporary and imitator at Weimar and Jena, among the nature philosophers, was Oken, who dealt with the type concept and wrote reams of mystical nonsense. As the botanist Kerner said, it seemed (over half a century ago) scarcely credible that the *Naturphilosophie* of Oken (1810) and other similar works down to the time of Unger (1843) should have been received as showing profound insight, or that their absurd propositions could have been adopted as mottoes to stand at the beginning of serious treatises. Kerner quotes from Oken as an example of fantastic nonsense the following:

A plant is a magnetic needle attracted toward the light from the earth into the air. It is a galvanic bubble and, as such, is earth, water, and air. The plant bubble possesses two opposite extremities, a single terrestrial end and a dual aerial end; and so plants must be looked upon as being organisms which manifest a continual struggle to become earth on the one hand and air on the other, unmixed metal at one end, and dual air at the other . . . A blossom, which, when severed from the stem, preserves by its own movement the galvanic process, or life, is an animal. An animal is a flower bubble set

free from the earth and living alone in air and water by virtue of its own motion.

Goethe, to be sure, did not himself perpetrate such maudlin ideas as these, but some of his own conclusions were so poised on the pseudoscientific border line that they could lead either toward science or toward mysticism.

Since it is so customary to pick quotations from Goethe singly and with too much eliminating, I wish to present in as nearly his own phraseology as possible the essential ideas of his doctrine of metamorphosis, leaving out only repetitious or unessential context.

He wrote:

We observe in various plants that one node springs from another . . . an upper node, since it arises from the one below and receives the sap by its mediation in a finer and more filtered state, improved by the action of the preceding leaves . . . must develop more perfectly and convey more delicate juices to its own leaves and buds. Since now the cruder saps are continually strained in this manner, and give rise to purer, the plant meanwhile improving itself step by step, the period prescribed by Nature is finally reached . . . It has been observed that copious nourishment hinders the production of the inflorescence of a plant, while a moderate or indeed scanty supply of food hastens it. The action of the stem leaves, considered above, shows itself here still more clearly. So long as cruder saps are still to be carried away, so long must there be production of those organs which are capable of fulfilling this need.

If excessive nourishment is forced upon the plant, this operation must be continually repeated, and flowering is thus rendered well-nigh impossible. If on the other hand, the plant is deprived of food, this natural process is facilitated and shortened; the foliar organs are refined, the operation of the unadulterated saps becomes purer and stronger, and the transformation of the parts is rendered possible and makes unimpeded progress . . . It may, it seems to us, be proved most clearly that the leaves of the calyx are the same organs . . . as stem leaves, but

are . . . collected around a common center . . .

This faculty of Nature, which assembles a number of leaves around a center, may be observed to bring about an even more intimate union . . . for it unites them between themselves . . . they anastomose through the influence of the extremely pure sap present by this time in the plant . . . In this way, then, Nature formed the calyx: she connected together round a center several leaves and consequently several nodes, generally according to a certain definite number and plan; these leaves and nodes she would otherwise have produced successively and at some distance from one another. If the flowering had been inhibited by the intrusion of superfluous nourishment, these leaves would have been spaced out and would have appeared in their earlier form. Thus in the calyx Nature produces no new organ, but she unites and modifies only the organs already known to us, and in this way achieves a step towards the goal . . .

We have seen that the calyx owes its origin to elaborated saps, which are engendered by degrees in the plant, and that it is thus in its turn adapted for the production of a future organ of a further refinement . . . The petals are generally larger than the sepals, and it is to be observed that the organs which were in a state of contraction in the calyx, at the stage now reached expand themselves as petals through the influence of purer saps, filtered through the calyx and in a high degree refined . . . It is a very plausible idea that the color and scent of the petals are to be attributed to the presence in them of the male seed. Probably this substance is contained in them in a state in which it is not yet sufficiently isolated, but mixed and diluted with other juices.

The beautiful phenomena of color lead us to the conception that the material wherewith the petals are filled, although indeed it has arrived at a high degree of purity, yet still has not reached the highest grade, in which it appears to us white and colorless . . . And so the stamens arise when the organs which we have hitherto seen expand as petals reappear in a



highly contracted and at the same time, a highly refined condition . . . We were actually able to observe that the stamens originated through contraction . . . In many examples, the styles are almost like filaments without anthers, and the relationship of their external form is closer than that of the other members. As they are both produced from spiral vessels, we see the more clearly that the female member has as little claim as the male to be regarded as an organ belonging to a special category . . .

We cannot fail to recognize the leaf nature of the seed vessels, notwithstanding their various forms, their special modification, and their relations among themselves. So, for example, the legume would be a simple folded leaf concrescent by its margins . . . Compound seed vessels would be explained as consisting of several leaves united round middle point, their inner faces open towards one another, and their margins united . . . The last and most expansion which the plant exhibits in its growth shows itself in the fruit . . . The seed draws upon the juices of the whole plant for its growth . . . With the help of these juices the (seed) vessels become nourished, dilated, and often in the highest degree filled and expanded . . . It may be concluded that the purer kinds of gas take a great part in this process. This idea is confirmed by the familiar fact that the distended legumes of *Colutea* (bladder senna) contain pure air.

Here the theory is stated without the evidence, of which Goethe uses little but which is much the same as that adduced by earlier and later authors who have developed the idea of homology in leaves and flower parts. The evidence which Goethe used was largely derived from the observation of intermediate or abnormal organs. He said himself that metamorphosis might be of three kinds, normal, abnormal, or fortuitous. The evidence for normal metamorphosis came from the abnormal, or reversed process in which, for example, sepals might take the form of foliage leaves or flowers might be doubled by stamens appearing as petals. In fortuitous metamorphosis, transformations were caused by parasitism by insects, and Goethe said we

should avert our eyes from such phenomena, which might divert the argument.

In the foregoing quotations I have taken care not to sort out the sense, but to leave it mingled with the nonsense, which was nearly as great nonsense when Goethe wrote it as it is now. The approval of Oken's much greater fantasies by his generation indicates the great willingness of the scientifically uncritical to accept whatever was presented obscurely enough so that it seemed profound whether it was or not, or presented attractively enough so as to arouse aesthetic appreciation.

We must now return to the problem of whether or not Goethe is to be classified as a forerunner of evolution or as a nature philosopher. The very difference of opinion about the matter indicates that his writings were ambiguous. His conception of metamorphosis was developed during a time when he was impressed by seeming inconsistencies and contradictions in nature, but was ardently seeking for unity and order. It came out of a time of mental turmoil when he was more than willing to interpret nature's apparent incongruities as masks under which essential unity was concealed. So in his doctrine of metamorphosis he may be thought to have presented an illustration of diversity masking actual unity, in the conception of a type organ, the original leaf, in conformity with which every variation of a leaf and every other lateral plant organ was constructed. It was a type of thinking that was entirely consistent with the doctrine of special creation. It required acceptance of the belief that there was design in nature; that the act of creation had been an act of uniting different variants of the same basic structures in all sorts of combinations and according to law, a sort of an organismal chemistry which allowed the performance of myriads of different syntheses. If the secret of some of the syntheses was not readily discerned, there was a problem for the morphologist, and morphology was the great science to be unfolded in the future. Analysis had to be carried out in order to understand the synthesis, for all organisms presented a set of homologies with all others.

This, it seems, was Goethe's conception, and the basis of his preoccupation with morphology. Darwin has taught us that the conception was erroneous. Still something of Goethe's biology remained after his ideas had had their influence and run their course.

Because Goethe detected a vestigial homologue of the intermaxillary (or premaxillary) bone in the human embryo, he has been credited with having been the first to recognize the importance of embryonic stages in the interpretation of adult structure. That is a basic conception of morphology, the science that he named and to which he devoted so much effort. Also, with modification, the doctrine of foliar metamorphosis remains, and Goethe was one of those who developed it. Furthermore, Goethe deserves much credit for his insistence upon the search for homologies, for they are the most important evidence of evolution.

Finally, there remains his biological law of compensation, credit for which he must share with others but which

was attributed to him by Darwin. On the whole, he cannot be denied an honorable place among scientists. Yet it seems certain that if he had never published anything at all, the progress of science would not have been at all retarded. It just happened that numerous workers were all pushing forward with ideas and evidence similar to his. In fact, Cole, the historian of comparative anatomy, has declared that Goethe's methods and results in morphology showed hardly any progress beyond Pierre Belon, who compared the skeletons of bird and man in 1555.

But suppose the whole structure of Goethe's science had crumbled, and nothing had been left. Could it be said that his pursuit of science had been useless? Is it not always worth while to seek for guiding principles, and to find them almost within grasp? The scientist, I believe, grants that the poet has a different function from his own, and the pursuit of science may have been an essential factor in the later development of Goethe as a poet. Its greatest significance may have been in molding his own mind.



## Mid-point in the Twentieth Century

The first half of the twentieth century seems to have been filled with turmoil, strife, struggle, fear, and conflict in all forms of human activities. It has been harassed with two major wars and many smaller ones, numerous revolutions, bitter labor battles, periods of depression and inflation, and rapid changes in political and moral attitudes. Fear, hunger, or war has troubled almost all sections of the globe during these years.

In spite of, or because of, this half-century of conflict, the rate of progress in almost every field of endeavor has been accelerated to such a pace that many people are frustrated in an effort to keep up with progress. Mankind's accomplishments include such diverse achievements as increasing life expect-

tancy, decreasing infant mortality, being able to kill more people faster than ever before, probing space and minds, making things faster with less human labor, developing a mechanical brain, organizing a United Nations, and formulating other political ideas, better sales techniques and conditions for labor. Communications have advanced.

The one great field which has been neglected, if not almost shattered during the first half of the twentieth century, is the art of living and understanding people. Let us hope that during the second half of the twentieth century a greater importance and emphasis will be placed on people living together and understanding one another—Johnson E. Fairchild, in *Cooper Union Forum Program*.



## EDITORIALS

### EXEMPLUM AD IMITANDUM

*(The editor quotes the tailpiece from "Shrubs of Michigan" reviewed in the section devoted to books. In case you've forgotten your Latin this heading means: "An example to be Imitated." There is an old Roman wise-crack which probably resulted in too close acquaintance with scorpions: "In cauda venenum!" There is no poison in this tail-piece,—it's mighty good and thinkable medicine.)*

"It is furthest from my desire to intrude too much of myself into this volume. After all it is a treatise on a segment of our flora and is not in any way an anthropological work. It is the aim of any such effort to be of help to others, and if my own experience can aid this effort it may be worth calling attention to.

When the first edition was written I was actively engaged in business, and the work was carried on in my spare time. I am now retired from the major portion of my business connections, and if I had not years ago taken up systematic botany purely as a hobby I might now be without any sort of useful occupation. Therein lies the suggestion to others who may read this bulletin and who may wish to profit by my experience. Systematic botany, with its many field excursions and contact with nature generally, furnishes relief and relaxation from the daily exactions of business and adds immeasurably to the joy of living. Later on in life if pursued consistently it may furnish a worthwhile escape from the deadly monotony of old-age retirement.

On one of my numerous visits to the University of Michigan Herbarium Dr. McVaugh expressed the wish that he had a number of persons to help with

the work there. Here would be a delightful way of relieving the monotony of retirement for any capable worker, at the same time achieving a most worthwhile end-result. The Cranbrook herbarium welcomes such assistance and already has the help of an enthusiastic group. There is room for more, however, and no doubt other institutions need and would welcome similar support. Not all places have herbaria to work in, but information and specimens are always welcome, and the director of any such institution would be more than glad to supervise the efforts of capable workers.

The opportunities are almost numberless, and there could be no greater reward than to feel that my experience, which has been most satisfactory in every way, had influenced others to pursue the same profitable line of endeavor."

CECIL BILLINGTON

### CONTRIBUTORS TO THIS ISSUE

Dr. Conrad A. Elvehjem whose thoughtful article on the role of the graduate student in the research program of a university occupies the first place in this issue of *The Biologist*, became a member of Zeta chapter of Phi Sigma in 1924 in the same initiation class with your editor. Since that time Dr. Elvehjem has gone a long way to occupy the important position he now holds as dean of the graduate school of the University of Wisconsin.

An enthusiastic research worker, and a real educator, he has contributed widely to the scientific press, he has co-operated in the production of symposia both heard and printed, and by these activities he has attracted the attention of the administration of his university which, when Dr. E. B. Fred

(Zeta '26) was promoted from dean of the graduate school to the presidency, moved Dr. Elvehjem into the vacant position.

Years ago, in "The Goose Step," that now-forgotten diatribe against American higher education, written by Upton Sinclair, the author characterized Wisconsin as some kind of a people's "university presided over by an elderly biologist." By so doing he gave that institution an accolade it appears unafraid to disown. That "elderly biologist," Dr. Edward Asahel Birge (Honorary Zeta 1924) is still active on the university campus, although in his nineties. His mantle of the presidency fell in turn first on the shoulders of the ill-starred publicist Glen Frank, then on Dr. Clarence A. Dykestra, now provost of the University of California, and finally on the present incumbent, Dr. E. B. Fred. If coming events cast their shadows before, we may hear more of Dr. Conrad Elvehjem. His scientific labors, now somewhat curtailed by his executive duties as graduate dean, have enriched our biochemical knowledge in animal nutrition, tissue metabolism, iron metabolism, food composition, and minor inorganic elements. His receiving the Willard Gibbs Medal, the Mead Johnson award, the Nicholas Appert Medal and membership in the National Academy, testify to his eminence in his field.

Another old-timer returns to our pages in the entirely unsolicited contribution from Dr. David Causey. For the benefit of all the newer members, it may be stated that Dr. Causey is a past-master of the n-th degree in the art of the scientific spoof. His contributions to *The Biologist* in years gone by were gleefully received. He was initiated into Phi Sigma by Mu chapter at the University of California in 1925. He did his graduate work at Princeton, where his doctoral dissertation on parasites was received with acclaim and subsequently published under the title "Uninvited Guests," with an enthusiastic introduction by Dr. Edwin Grant Conklin.

At the seventh national meeting in St. Louis, 1935, Dr. Causey was the banquet speaker. His topic, "The Decadence of the Male in the Animal

Kingdom," caught the fancy of one of the science-publicists present, the late Dr. Frank Thone of "Science Service." Dr. Thone secured the copy of Dr. Causey's paper and gave it a full two-page spread in a Sunday supplement for the syndicated Scripps-Howard papers. The favorable publicity Phi Sigma indirectly received by this journalistic "scoop" was no mean factor in the society's growth during the next few years.

Dr. Causey's humor has mellowed with the years. He has become one with the scientific humorists of our history. Now and then one detects flashes not unlike the writings of the author of "The Autocrat of the Breakfast Table," the first Oliver Wendell Holmes.

The scientific pedigree and fame of Dr. Harley Harris Bartlett has been very briefly summarized in the footnote to his paper on Goethe. What is not so well known about him, however, is that in 1917 he entered Phi Sigma in the third year of its existence through Beta chapter at the University of Michigan.

Dr. Bartlett is a wide-ranging scientist. He has been on innumerable commissions, and scientific expeditions. His research has taken him into genetics, systematics, agronomy and biochemistry. He is an expert on tropical exploration and his teaching work in the Philippines, as well as his travels in Mexico, Honduras, Guatemala, Sumatra, Formosa and Japan, have all given him a breadth of vision that makes him a revered and welcome arrival in these pages.

#### LOOKING AHEAD

Sometime next winter, probably between Christmas and New Year, there should be another meeting of the chapter delegates. The Council is meeting early in September to lay plans for this event. In connection with each of these sessions since 1925 there has almost always been a period or two devoted to the reading of scientific papers, reports, abstracts or titles of research in progress. The only recent gap in this procedure was in the first post-war Boston meeting in 1946.



This is a distinctive part of our meetings. As far as we know Phi Sigma is the only honorary society in any branch of collegiate activity which carries over this custom from the great professional organizations.

Such a program cannot be something cooked up on the spur of the moment. It must be looked forward to and prepared for. If the chapter delegate is not ready to present a paper himself, he can bring along and present the papers of other members of his chapter. Papers should not be long, a maximum of ten or twelve minutes is ample time to present a lot of data. Most scientific papers presented at the sessions of the American Association for the Advancement of Science are much

shorter than this. Some do not run over four or five minutes.

The Executive Secretary, Dr. Henry vander Schalie, has sent all chapters notices of the forthcoming Council Meeting to be held in Denver early in September. One of the most important items of business on the Council's agenda will be the selection of a place for the December meeting. Those who attended the last one at the University of New Mexico in Albuquerque will not soon forget the hospitality the University, its Biology Department, and Alpha Nu chapter extended to the delegates and the council members.

Chapters of Phi Sigma who would like to have the December meeting at their home campus are urged to send the invitations to Dr. vander Schalie.



## New Approach to Problems of Study

The days when freshmen at Syracuse University were allowed to flounder around and shift for themselves academically are fast becoming a part of the forgotten past. No longer must the student who is having difficulty in his courses drop out of school or seek the services of an expensive tutor.

Taking the place of inefficient study methods, inferior classroom techniques, and even the time-honored custom of "cramming," are new Higher-Level Work Skills, as fostered by the *Improvement of Learning Staff*.

This group of instructors is part of the S. U. Reading Laboratory, headed by Dr. William D. Sheldon. Their work includes finding out the deficiencies of students who are not getting the most out of college, pointing out effective remedies for these deficiencies and assisting their students to reach the goals set for them.

All this is accomplished in a course now offered for credit to freshmen and selected upper-classmen. Many Syracuse alumni will be surprised to learn that this is not an entirely new program, but one which has been in the formative stages at their Alma Mater for the past thirty years. It has been during only the past four years, how-

ever, that the greatest progress has been made and the program has reached credit-course proportions. The staff now includes some twenty instructors with nearly 700 students on the Hill, at University College, and at Utica College each semester.

Recognizing the need for improvement of study methods, S. U. authorities are now requiring the course for many entering freshman and transfer students. This is the outgrowth of an attempt to study with increasing care the needs of students at the time of admission. Following a complete diagnosis of a student, provisions are made for corrective and remedial training...

An opportunity is offered each student for unlimited counseling and guidance. During the semester a minimum of four interviews is held between student and instructor for the discussion of problems, outlining of remedial plans, and evaluating progress. If personality, constitutional, emotional, or vocational problems are indicated, provisions are made for additional testing and guidance through the Psychological Services Center. These services are free to University students.—Warren G. Cutts, in *Syracuse University Alumni News*.

## NEW BOOKS

*This section offers brief uncritical reports on the general content of recent publications in biological and related fields. Only the longer critical reviews will be signed. For quick location on library shelves, each notice will be preceded, wherever possible, by three groups of numbers, the first two of which will be the Dewey and the Library of Congress classified numbers respectively. The third group is the L.C. card number, for the convenience of Librarians.*

AMERICAN WILD FLOWERS, HAROLD M. MOLDENKE, D. Van Nostrand Co., Inc., New York, Toronto and London, 1949, 453 pages, \$6.95.  
582.13      QK115.M6      49-5118

Like its predecessor in this section this is another of the "new Illustrated Naturalist" series, this volume from the pen of the curator of the New York Botanical Garden Herbarian, gives all evidences of particular care in its fashioning. It embraces all the living types bounded between Canada and Mexico, the east and west coasts. All illustrations are photographic, exactly half in color. There is a 50-page index which is a honey.

ANATOMY AND PHYSIOLOGY LABORATORY MANUAL, VERA MARCH VOGEL and JESSE D. PARKINSON, C. V. Mosby Co., St. Louis, Mo., \$2.75.

A comprehensive series of exercises based on the integrated human body as a theme. All drawings needed are ready for labelling, being presented either as sketches or photographically.

ANCIENT MAN IN NORTH AMERICA, by H. M. WORMINGTON, Denver Museum of Natural History, Denver, Colo., Paper \$1.50 and Cloth \$2.50.

This slim 200-page brochure comes from the Curator of Archaeology at the Denver Museum. It also contains an appendix on the geology of the *clovis* sites, by Ernst Antevs. For anyone who wants the final up-to-the-minute

data on our prehistoric predecessors, this is IT.

APPLIED BIOPHYSICS, Edited by N. HOWARD JONES, Chemical Publishing Co. Inc., 26 Court St., Brooklyn 2, N. Y., 1949, 293 pages.  
612.0144      QH505.H63      49-11475

This symposium consists of papers on biophysical factors in drug action, heat application, brain injuries, radiation effects of all kinds, their measurement, and methods of use. The authors are all engaged in active work in British hospitals, research institutions or universities.

ATLAS OF DRAWINGS FOR CHORDATE ANATOMY, by SAMUEL EDDY, John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., \$3.50.

Dr. Eddy is Professor of Zoology at the University of Minnesota. His latest offering is a large, spirally bound volume of detachable sheets of most excellent illustrations for labelling in a course on the *chordata*. There is no other printed matter in the book. The student must therefore do all his labelling from knowledge or other reference works. This selection runs from the external view of amphioxus to a sagittal section of the cat brain in 183 separate illustrations.

AUSTRALIAN ANIMAL BOOK, by CHARLES BARRETT, Oxford University Press, 114 Fifth Ave., New York 1,



N. Y., 1949, 374 pages, \$4.50.  
591.994 QL338.B3 44-9054

Thousands of former American service men who spent part of their military careers in the strange but home-like land "down under," would like to own this book, if they only knew about it. In forty well-illustrated chapters, it covers practically all the more significant animal types of the continent. The treatment of each group of mammals, birds, reptiles, fishes and introduced animals is crammed with ecological detail yet discursive enough to make for easy reading by anyone interested. Dr. Barrett's recognized position in Australasian biology vouches for its accuracy.

BIOLOGY, ITS HUMAN IMPLICATIONS, by GARRETT HARDEN, W. H. Freeman and Co., 549 Market St., San Francisco 5, Calif., 1949, 645 pages, \$5.00.

The west coast of the United States is becoming increasingly articulate and for the first time textbook publication on a large scale has been attempted. This first biology text to come from the coast, both as to authorship and publication, brings with it a refreshingly clean-cut approach. It is definitely *homocentric*, both as to subject matter and as to method of presentation. It does not bewilder the beginning student with a flood of little-used terminology, and goes out of its way to integrate easily and naturally both botany and zoology as well as microbiology. Best of all, the illustrations are refreshingly new, both in kind and in treatment.

BOTANY, by J. BEN HILL, LEE O. AVERHALTS and HENRY W. POPPE, The McGraw Hill Book Co., 330 W. 42nd St., New York 18, N. Y., 1950. 710 pp., 335 figs., \$5.00.

This is the second edition of the original work which first appeared fourteen years ago. In this presentation much of the original matter has been thoroughly reworked in order to bring the war-time experimental results into proper focus. New studies on photosynthesis, respiration, antibiotics, hydroponics and "tagged elements" are all included.

BOTANY, by W. W. ROBINS and T. E. WEIER, John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y., 1950, 480 pp., 490 illus., \$5.00.

This entirely new textbook has probably the largest number of illustrations ever seen in any similar publication. They average better than one to a page. This in itself would not be so remarkable if the pictures were of more or less traditional types that have been handed down from author to author since Strassburger's time. Very few of them are. Almost all are new,—and most of them are of a clarity that is refreshing. Every textbook is the projection of a teacher's convictions and techniques. Dr. Robins and his associate have much to commend their book in that they know the science teaching game from the ground up.

COMPARATIVE ANATOMY LABORATORY MANUAL, by L. P. GRIBBLE, The Blakiston Co., Philadelphia, Pa., 1950, 232 pages, \$3.00.  
591.4072 QL812.G77 50-5741

Bound in heavy paper, well printed and illustrated with some 95 figures on 41 plates, this laboratory manual treats its material under the headings of appendicular skeletons, axial skeletons, muscles and glands, digestive and hepatic portal systems, urogenital and renal portal systems, circulatory systems, respiratory systems and nervous systems. Not all of the source material is treated under each of the foregoing, which is not hard to understand, since the author makes free use of amphioxus, dogfish, carp, frog, necturus, turtle, alligator, pigeon, chicken, bat, seal, woodchuck, cat and sheep. There is also a whole chapter on anomalies in the Cat.

CONCISE LABORATORY MANUAL AND ATLAS FOR COMPARATIVE ANATOMY, by W. H. ARWOOD, The C. V. Mosby Co., 3207 Washington Blvd., St. Louis 3, Mo., 1949, 129 pages \$2.75.

Based on *Amphioxus*, *Squalus*, *Necturus*, the bull frog, the alligator and the cat, this manual has 55 clear-cut illustrations, most of them prepared for labelling, some even with guide lines for the purpose.

DEATH OF A SCIENCE IN RUSSIA, by CONWAY ZIRKLE, University of Pennsylvania Press, Philadelphia, Pa., 1949, 319 pages, \$3.75.

575.12 QH431.Z53 49-50071

Fresh from the presses, this timely volume brings together all the important documents, both U.S. and U.S.S.R. on the liquidation of classical genetics in Russia. It all began back in 1936 with the rise of the Russian "Powers That Be." By the end of 1948 all vestiges of Mendelian genetics had disappeared from the educational scene in the U.S.S.R., a good many of them forcibly. This story of the whole scientific tragedy ought to be in every American student's hands. Given federal domination of research "it could happen here." Unfortunately the book lacks an index.

DECAY OF TIMBER AND ITS PREVENTION, by K. H. G. CARTWRIGHT and W. P. K. FINDLAY, Chemical Publishing Co., Inc., 26 Court St., Brooklyn 2, N. Y., 1950, 294 pp., 49 pl., 10 tab., 8 fig., \$7.50.

Emanating from the British Forest Products Research Laboratory and compiled with that meticulous care one associates with European scholarship, this finely printed volume will undoubtedly find its place in every wood and forestry research library shelf. The book is copiously annotated, each chapter ending with from one to three pages of references,—of which a slight majority come from British, Canadian and U.S. sources. The rest are from the continent, mostly German. In his treatment of the various rot types, their causes, effects and treatments or prevention, the problem is approached from the British angle, but in practically every case, American equivalents are also discussed. Culture methods and techniques are clearly presented. In treatment techniques U.S. readers may need to be reminded that in the Empire, railroad rails are laid on "sleepers" instead of "ties."

THE ELEMENTS OF GENETICS, by C. D. DARLINGTON and KIRTLEY MATHER, The MacMillan Co., 60 Fifth Avenue, New York 11, N. Y., 1949, 446 pages, \$3.75.

575.12 QH431.D2115 50-1518

The authors of this new contribution have said about all there is to say about the scope and purpose of their work. "In the present account of genetics we have tried to use what is known in order to find out what is unknown. As a consequence there stretches a complete range, in a gentle gradient or cline, from the old theories of Chapter 1, which are called 'Laws of Nature' to the new theories of Chapter 16, which are called 'Dangerous Speculations!'" The reader will don his doubting glasses at the point he feels proper. He will do well, however, to recollect that this is the first attempt to represent the whole scope of genetics, the whole of what has always been needed.

EXPERIMENTS IN SOIL BACTERIOLOGY, by O. N. ALLEN, the Burgess Publishing Co., 426 South 6th Street, Minneapolis 15, Minn., 1949, 126 pages, \$2.50.

This spirally bound laboratory manual outlines the experimental work required of students in this subject at the University of Wisconsin. The three main parts of the work cover a survey of soil microflora, microbiological activities in soil, and biological methods of determining mineral deficiencies. Under each of these main headings there are a number of experiments which bring out the importance of much more than merely the bacterial content of soils.

FERNS AND FLOWERING PLANTS OF SAN DIEGO COUNTY, by ETHEL BAILEY HIGGINS, San Diego Society of Natural History, San Diego, Calif., 1949, 174 pages and map.

The paper-covered, volume covers much of the plant life of the southwestern-most county of the United States,—being bounded on the south by Mexico and on the west by the Pacific Ocean. It will be of interest to taxonomists in general and to all plant lovers.

FOUNDATIONS OF BIOLOGY, by A. M. WINCHESTER, D. Van Nostrand Co., 205 Fourth Ave., New York 31, N. Y., 1949, 777 pages, \$5.75.

The forty-nine chapters of this new general biology text are crammed with more than enough information for a thorough freshman year course. The author's viewpoint is new and refreshing. Part one of the book is devoted to six introductory chapters on the scope of biology, the cell and its nature and division, physiological processes and a preview of taxonomy. Part two deals with the plant phyla in five chapters. Part three devotes one each to the root stem and leaf systems. Part four treats the animal phyla in fourteen chapters. Part five uses up nine chapters on the animal organ systems. Part six covers a number of other topics, including microbiology and disease, entomology, heredity, evolution, paleontology including humans. The last chapter is devoted to a swift survey of history-making biologists.

**HISTORY OF NATURE**, by C. F. VON WEISZSACKER, University of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill., 1949, 192 pages, \$3.00.

The author of this weighty little book earned his place in science by his establishment of the Rand-Laplace nebular theory of evolution of our planetary system. Here in 12 short chapters he sums up the origin of things from infinity through the physical, chemical, and biological stages to man. As an integrator of thought and action, this volume has much to offer.

**HIVE AND THE HONEY BEE**, Edited by ROY A. GRANT, Dadant and Sons, Hamilton, Ill., 1949, 652 pages.

The publishers of the American Bee Journal have commissioned Roy A. Grant and his associates to bring "Langstroth on the Hive and the Honeybee" up to date in an almost completely rewritten new work. Hence, the twenty-three chapters are the individual contributions of some sixteen beemen, all specialists in their respective fields. Without undue exaggeration this volume might well have been called "an encyclopedia of bee-keeping."

**ISOTOPIC TRACERS AND NUCLEAR RADIATION WITH APPLICATIONS TO BIOLOGY AND MEDICINE**, by WILLIAM E. SIRS, and others. McGraw Hill Book Co., Inc.,

330 West 42nd St., New York 18, N. Y., 1949, 653 pp., 136 illus., and 49 tables, \$12.50.

574.1072 OH505.S5 49-11266

Assisted by E. C. Daugherty, R. W. Dunn, J. L. Robertson, C. A. Tobias and P. P. Weymouth, of the division of medical physics, department of physics and radiation laboratory, University of California, the senior author of this volume attempts to bring together as much as possible of the widely scattered research and experimentation that has gone on from both the biological and the medical angles. The book is divided into three parts: Isotopes and nuclear radiations; methods and instruments; biological and medical applications of isotopes. The bibliography, divided under sub-headings by the chemical elements, is tremendous, occupying as it does the whole last chapter and running up to 90 pages in length.

**KEYS TO THE COMMON FLESHY FUNGI**, by CLYDE M. CHRISTENSEN, Burgess Pub. Co., 426 South Sixth Street, Minneapolis 15, Minn., 1946, 45 pages, 7 plates, many textfigures, \$1.50.

Two hundred fifty gilled fungi and over one hundred other fleshy fungi are treated in this spirally bound field manual, which can be recommended for its simplicity and ease of consultation.

**LABORATORY AND FIELD EXERCISES IN BOTANY**, by FRED W. EMERSON and LORA M. SHIELDS, The Blakiston Co., Philadelphia 5, Pa., 1949, 303 pp., 34 plates, 2 fig., \$2.50.

Sixty-eight exercises presented here offer some leeway of choice to the instructor who is trying to cram the whole of a Botany One course into one semester. But a few of the exercises—freshmen being what they are nowadays,—are much too long. Where culturing on blood-agar the throat exudates from students with colds is regarded as dangerous or forbidden, part of the experiment on bacteria could be omitted. On the whole this manual compares otherwise very favorably with others we have seen or used. What commends it mostly to us is its helpful and very practical supply schedule,



preparation roster and its itemized list of supplies, equipment and formulae.

**LABORATORY MANUAL OF VERTEBRATE EMBRYOLOGY**, by F. ADAMSTONE and W. SHUMWAY, John Wiley & Sons, Inc., 440 Fourth Ave., New York 10, N. Y., 1947, 96 pp., 38 figs., \$2.00.

591.3072 QL957.A3 48-4026

This second edition of a manual which originally appeared in 1939, has been brought up-to-date, clarified, and otherwise improved. There is ample space for drawings, since the 38 figures in the text are all carefully labelled.

**LIFE AMONG THE DOCTORS**, by PAUL DE KRUIF, Harcourt, Brace and Co., 383 Madison Ave., New York 17, N. Y., 470 pp.

926.1 R153.D4 49-10896

These are the stories behind many if not all of the medical articles which have appeared in "Readers Digest" during the past nine years. The chief characters are Clifford C. Young for whom Michigan's Public Health Laboratory is named; Dr. Tom D. Spies of Birmingham, Alabama; Dr. Herman Bundesen of Chicago; Dr. Al Coburn of the Northwestern University Medical School; Dr. Leo Loewe of Brooklyn Jewish Hospital; Col. O. C. Wenger of Hot Springs; Dr. Herman Kabat of Washington, D. C., and Dr. Sidney Garfield of California's Permanente Hospital Foundation. This is the twelfth in the series of De Kruif's crusading works. In technique of presentation alone, it shows that he has matured without losing his drive or punch.

**LIFE OF WILLIAM T. DAVIS**, by MABEL ABBOTT, Cornell University Press, Ithaca, N. Y., 1949, 321 pp. illus., \$3.50.

925.7 QH31.D42A6 49-11768

Here is the life of an esteemed personality in the fields of biology, mostly interested in entomology, but catholic enough in his taste and omniscient enough in his knowledge to be able to turn from his beloved seventeen-year locusts to report the occurrences of new clumps of hybrid oaks, chestnut fungi, new locations for hyllida, rattlesnake bite,—the list of his publications is too

varied to enumerate all his interests. In the 51 producing years of his life he authored alone or jointly over 550 papers. Not many of them were long. All of them were interesting. He was closely associated with some of the giants of the taxonomic world not only in his chosen field, but in botany, herpetology and ornithology. His life and its story will always remain a blessing and encouragement to all naturalists.

**MANUAL OF BACTERIAL PLANT DISEASES**, by W. J. DOWSON, Macmillan Co., 60 Fifth Ave., New York 11, N. Y., 1949, 183 pp., 54 illus., 18 maps, \$2.50.

In a brief space, Dr. Dowson, (now of Cambridge, formerly at the Tasmanian Dept. of Agriculture), has crammed a lot of information. The book is divided into four general chapters, three on special methods, and five on Gram-positive and Gram-negative plant pathogens. The world distribution of these forms is well handled by means of outline maps.

**MARRIAGE**, by ROBERT A. HARPER, Appleton, Century, Crafts, Inc. 35 West 32nd Street, New York 1, N. Y., 1949. 308 pp. \$2.75.

392.5 HQ734.H295 49-8683

Dr. Harper is a member of the department of Sociology at Ohio State University. This new book is representative of the better type of literature that is growing up around the socially important and racially essential facts of mating and home making. It is factual without being preachy. One point the author might have stressed more than he did is the World War II lesson that combat fatigue cases and just plain being "nervous in the service" was much more common among men who came from broken homes, or homes in which insecurity was the general order from birth on.

**MAYFLIES OF FLORIDA**, by LEWIS BERNER, University of Florida Press, Gainesville, Fla., 1950, 268 pages, 88 text figures, 24 half-tones, 19 maps, \$5.50.

595.734 QL513.E7B4 50-6383

The author of this monograph, Dr. Berner, has devoted much careful work, and shows his varied experience, in the

preparation of this volume. His years in malaria control work in British West Africa, and his familiarity with the breeding places of the Floridian Ephemoptera are reflected in this unusually well written and beautifully illustrated paper-bound volume.

**MICROBIOLOGY**, by F. C. KELLY and K. E. WHITE, Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y., 1949, 592 pp., 185 fig., 22 tables, \$6.50.

589.95 QR46.K4 49-49053

Cutting away from the more stereotyped and traditional bacteriologies, this new text is divided into eight parts and an appendix. The first covers a seven-chapter introduction to the microscopic world, including protozoa, algae, fungi, bacteria and viruses. The second devotes five chapters to methods for studying micro-organisms. Part three has three chapters on the physiology of bacteria. Part four devotes two chapters to microbial populations. The next discusses intimicrobial methods under three headings. Part six treats of micro-organisms and disease. Part seven is a long section running through chapters 25 to 42 and covering the whole gamut of pathogenic microbiology. Part eight has three chapters on epidemiology and public health. The appendix contains a brief historical review of the science and a good-sized section on technical methods in bacteriology.

**MILITARY MEDICAL MANUAL**, The Military Service Publishing Co., 100 Telegraph Bldg., Harrisburg, Pa., 1944, 889 pp., \$4.50.

This is the last edition of the ROTC medical manual in use in pre-war days. It contains the preliminary section on military training, map reading etc., followed by general medical subject, sanitation, hygiene and first aid. The third part is devoted to medical tactics and administration, organization of medical units, etc. This manual has not been superseded, largely because of the indecision as to the fate of the military medical services. If army, navy and air medical services are to be consolidated in the present unification program, as some think likely, books like this will become museum pieces.

**MODERN SCIENCE AND ITS PHILOSOPHY**, by PHILIPP FRANK, Harvard University Press, Cambridge 38, Mass., 1949, 324 pp., \$4.50.

49-1001L

The author of this volume is a Viennese philosopher who has come to this country to hold a position as lecturer on physics and mathematics at Harvard University. He represents that section of modern philosophical thought which goes under the impressive title of logical empiricism. Since he is the only author who has embraced this particular approach to a philosophy of science he naturally has the field pretty much to himself. His favorite method of attack seems to be to pit different philosophical systems against each other, positivism, dialectic materialism, and neo-Thomism coming most frequently under his hammer. In that he is emphasizing logical relationships in science, he is helping science to straighten its thinking. Whether his philosophic system will solve the philosophical problems of physics and mathematics, of course, remains to be seen.

**NATIVE TREES OF FLORIDA**, by E. WEST and L. E. ARNOLD, University of Florida Press, Gainesville, Fla., 1948, 212 pp., illus., \$3.75.

582.16 QK484.F6W4 46-27386

Anyone professionally interested in the flora of the southern states will welcome this third reprinting of a local manual which effectively covers the trees of Florida. It is not generally known that the palmetto state possessed at one time over three hundred native species of trees (and arborescent shrubs large enough to be called trees.) Thus richly endowed, Florida needed a well illustrated manual to describe its treasures. In meeting that need, West and Arnold have done a good job.

**THE NATURAL BENT**, by PAUL B. BARRINGER, The University of North Carolina Press, Chapel Hill, N. C., 1949, \$3.50.

926.1 R154.B27A3 49-6689

Born in 1859 and dying in 1941, Dr. Paul Barringer's life covered the latter half of the 19th century as well as the first half of the 20th. This book is taken from his memoirs and covers in much of his youth with scant or no

attention to his later professional career as a medical doctor at the University of Virginia. Hence the author's engaging experiences after 1881 when he returned from practice in Vienna are left to the imagination. The title of the book is from Plato's Republic: "Let early education be sort of amusement, you will then be able to find out the natural bent."

**NATURAL HISTORY OF MARINE ANIMALS**, by G. E. and N. MAC GINTIE, McGraw Book Co., Inc., 330 West 42nd St., New York 18, N. Y., 1949, 473 pp. 282 illus., \$6.00.  
591.92 QL121.M2 49-9159

The senior author of this work, in addition to his other duties, is director of the Keschhoff Marine Laboratory. As such the Mac Ginties have had all the usual museum-visitor questions to contend with, and the usual visitor surprise at some of the oddities that exist in almost every good collection of marine forms. This is something which has been driven home to this reviewer who thought he was pretty familiar with most of the coast forms until this Pacific coast manual came on the market. Not only are most of the unusual forms adequately described, some of them are beautifully pictured. As far as teaching general zoology is concerned this book has something to add to making the course interesting.

**NATURAL HISTORY OF MOSQUITOES**, by MARSTON BATES, The Macmillan Co., 60 Fifth Ave., New York, N. Y., 1949, 379 pp., 30 illus., 9 figs., \$5.00.  
595.771 QL536.B38 49-9326

Dr. Marston Bates of the Rockefeller Foundations International Health Division Staff is in a unique position to write authoritatively about his subject. He does not attempt any anatomical studies. His work with its 45 pages of bibliography, is compendious, but the list of references is by no means complete. One could explain his missing D. J. Lee's "Atlas of the Mosquito Larvae of the Australasian Region," 1944, or the "Notes on Mosquito-borne Diseases in Australia" by Mackerras, 1943 since there were issued (as more or less restricted material) by the Adjutant General of the Australian Military Forces.

What is not so easy to explain is his passing up the American Entomological Society's "Mosquito Atlas" in two parts, 1943 by E. S. Ross and H. R. Roberts, or "The Anopheline Mosquitoes of the Northern Half of the Western Hemisphere and the Philippine Islands," by J. S. Simmons and T. H. G. Aitken, published by the Surgeon General, U.S.A. in Jan. 1942, or the reports on new species from the Solomon Islands and New Guinea which appeared in the Journal of the Washington Academy of Sciences in 1944 and 1946. The former dealt with a new anopheline *A. lungae* reported by J. N. Belkin and R. J. Schlossen. The latter, by W. V. King and H. Hoogstraal announced the identification of three new species of the genus *Aedes*. J. Forbes and W. R. Horsfall's 1946 paper, in the Annals of the Entomological Society of America on the "Biology of a Pest Mosquito common in New Guinea," dealt with the life history and habits of *Aedes scutellaris*. This was a careful little paper that could have been included.

This work has so many commendable points that these slips can be overlooked. The chapter on "The Species Problem" and those on classification, distribution, as well as techniques and strategy in mosquito study are worthy of attention.

**NATURE OF NATURAL HISTORY**, by MARSTON BATES, Charles Scribners Sons, 597 Fifth Ave., New York 17, N. Y., 1950, \$3.50.  
574 QH309.B34 50-6446

This most recent book by the author of "The Natural History of Mosquitoes" is a study in the approach to the sciences. As such it is devoted to the special attitudes of science, as indicated in these random choices from the chapter headings: naming of organisms, reproduction, environment, biotic communities, parasitism, behavior of populations, adaptations, natural history and human economy.

**NEW GOULD MEDICAL DICTIONARY**, edited by HAROLD W. JONES, NORMAND L. HOERR and ARTHUR OSOL, The Blakiston Co., 1012 Walnut St., Philadelphia 5, Pa., 1949, 1294 pp.,



45 plates, \$8.50 (textbook), \$10.75 (thinpaper), \$13.50 (de luxe).

610.3 R121.B62 49-5976

This first edition of a series of dictionaries which appeared under a variety of names has four impressive two-column pages listing the eighty collaborating contributors. Most of them are members of University Medical schools in the U. S. and Canada. Only the new and unusual terms are phonetically pronounced. There are some thirty-five not always otherwise accessible tables of valuable information in the back of the book.

NEW THEORY OF HUMAN EVOLUTION, by SIR ARTHUR KEITH, The Philosophical Library, 15 E. 40th St., New York 16, N. Y. 1949. \$4.75.

572 GN356.K45 49-8725

The noted author of this new book takes this occasion to sum up all his conclusions on the origins of the human race. He does not regard human evolution as some far off past historic event. He feels that it is happening now before our eyes, and, in his closing words, "In the clash and turmoil which disturbs the peace of the modern world we are hearing the creaking wheels of the 'machinery of evolution.'" In the development of this thesis he has definitely cast off the once popular hypothesis of mankind's polyphyletic origin.

NORTH AMERICAN WATERFOWL, by ALBERT M. DAY, Stackpole and Heck, Harrisburg, Pa., 1949, 329 pp., 59 pl., \$4.75.

799.244 SK361.D28 Agr 49-445

Ecologists are sometimes conservationists and even duck-hunters. If they are they will thoroughly enjoy this book. It has been claimed to be the most honest book on wild duck management ever written, as well as the best book on ducks. The author is the director of wildlife service, U.S.D.I. He speaks from knowledge and experience of some of the weirdest situations whose existence the larger portion of our people do not suspect.

NOTA TAXONOMICA, by FRED BARKLEY, Revista Facultad Nacional de Agronomía, Vol. VIII, No. 3 Bibli-

oteca, apartado, Aereo 568, Medellin, Colombia, S. A. 1948.

This is a combined 80-page list of the orders and families of the Anthophyta, followed by a 126-page index of the orders, families and genera of the Colombian plant types. There is a concluding paper on the phylogeny of the Anthophyta. The entire publication is in Spanish.

NOTES ON MICROSCOPICAL TECHNIQUE FOR ZOOLOGISTS, by C. I. A. PANTIN, Cambridge University Press, 530 Canal St., New York 13, N. Y., 1949, 80 pp., \$1.75.

This brief manual packs a tremendous amount of worthwhile information into a very minute compass. It is simply a laboratory manual based on methods found satisfactory for the advanced students of the Department of Zoology at Cambridge. It covers all the routine general methods of tissue preparation, mounting, staining, etc. There is a section on special methods for nervous system, cytoplasmic inclusions and the like, including protozoa. The appendix offers some interesting suggestions on cultivation of organisms, saline media, etc.

OUTLINES OF BIOCHEMISTRY, by ROSS A. GORTNER, John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1949, 1078 pp., 125 fig., \$7.50.

This third edition of a well-known text is edited by the author's sons, Ross A. Jr. and Willis Alway Gortner, with the cooperation or collaboration of eight other friends of the late senior author. The book is not devoted to any applied form of biochemistry. It is neither medical nor agricultural. It approaches the subject through the colloids, the proteins, the carbohydrates, the lipids, the plant pigments, and the biochemical regulators.

PAGEANT OF LIFE SCIENCE, by MAX W. DE LAUBENFELS, Prentice Hall, Inc., 70 Fifth Ave., New York 11, N. Y. 1949, 407 pp., 1024 figures, \$5.95.

574 QH308.D4 49-6162

This book was reviewed here when it first appeared as a lithoprinted volume. Now it is out in the customary format, shiny paper, 276 halftone illus-

trations, 748 line drawings and all. The book is as extraordinary as it ever was. Just the sort of thing a "quiz kid" would eat up,—some 5000 "fascinating subjects—making this a bonafide encyclopedia in one volume," as the book jacket says. If you wish to convey encyclopedia knowledge in your freshman biology courses, this is your proper fare.

PEACE OR PESTILENCE, by THEODOR ROSEBURY, Whittlesey House, The McGraw Hill Book Co., 330 West 42nd St., New York 18, N. Y. 1949, 218 pp. \$2.75.

This discussion of all the pros and cons of bacteriological warfare is something more than an eyeopener. In it the whole situation is clearly and intelligently put forth for the most unlearned to see. Among the bacterial or virus forms discussed are anthrax, botulinus, brucella, cholera, diphtheria, glanders, influenza, melicodosis, plague, psittacosis, tetanus, tularemia, typhus, and yellow fever,—most of which can be scattered by airborne means.

THE PHARMACOLOGY AND TOXICOLOGY OF THE URANIUM COMPOUNDS, edited by CARL VOEGTLIN and HAROLD C. HODGE, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y., 1949, two volumes, 1084 pp. illus., \$10.00.

615.9 RA123.1U7V6 49-9951

The fiendish power released in the A-bomb experiments has given uranium and its compounds a not-undeserved sinister reputation. The uranium compounds are toxic, but just how badly was not thoroughly understood until the production of atomic energy became a matter of international tactical importance. The results of three years of research to determine just how dangerous these compounds might be are here presented under expert editorship.

PRINCIPLES OF ANIMAL ECOLOGY, by W. C. ALLEE, A. E. EMERSON, O. PARK, T. PARK and K. P. SCHMIDT, W. B. Saunders Co., West Washington Square, Philadelphia, Pa., 1949, 837 pp., 236 figures, \$14.00.

591.5 QL751.A616 49-48297

This new volume on animal ecology merits the little-used term "opus magnum." It is really quite tremendous in its scope. Divided into five sections, it covers the history of ecology, analysis of environment, populations, the community, and ecology and evolution. If it isn't used as a textbook because of its inclusiveness, it should at least be on the library reference shelf.

PRINCIPLES OF INSECT PATHOLOGY, by EDWARD A. STEINHAUS, The McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y., 1949, 757 pp., 219 figs., \$8.00.

595.7 SB942.S77 Agr 49-450

This is a completely new book, intended either as a class room text or as a reference work for entomologists, agriculturists and biologists. Since its title reveals its purpose, it may well be expected to deal with many forms of epizootics, and their availabiltiy in insect pest control. As such the theme does not touch on any of the phases of medical epidemiology.

PSYCHOLOGY OF PERSONAL ADJUSTMENT, by FRED MCKINNEY, John Wiley and Sons, 440 Fourth Ave., New York 16, N. Y., 1949, 752 pp., illus., \$6.00.

371.422 BF636.M237 49-4607

Dedicated to college students, this book may help many who are in need of the salutary horse-sense which this experienced student counselor sets down in these pages. The advice is not high-hat, it's straight from the shoulder common-sense, the kind unhappy college students need. Not all friends or contacts are lost through halitosis. This book explains most of them.

PUBLIC HEALTH AND HYGIENE, by CHARLES FOND, NILS W. BOLDUAN, W. B. Saunders Company, West Washington Square, Philadelphia 5, Pa., 1949, 423 pp., 84 figs. \$4.25.

614 RA425.B72 49-9275

This fourth edition first discusses general principles and techniques, communicable diseases, insects, disinfections, principles of nutrition, transfusions, and social and economic factors in public health. The second part of the book discusses the more important communicable diseases. The third is

devoted to noncommunicable diseases. Part four is devoted to community hygiene. Part five concludes the book with six chapters on health administration.

**QUANTITATIVE ULTRAMICRO-ANALYSIS**, by PAUL L. KIRK, John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y., 1950, 310 pp., 113 figs., \$5.00.

545 QD117.K5 50-5699

While this is not a large book, it amply covers the field. There are chapters on volumetric apparatus, colorimetry apparatus, microgram titrimetry, metallic and non-metallic constituents, volumetric gas methods, spectrophotometric and physical methods. Dr. Paul Kirk, the author, is professor of biochemistry at the University of California.

**SELECTED INVERTEBRATE TYPES**, edited by FRANK A. BROWN, JR., John Wiley & Sons, 440 Fourth Ave., New York 16, N. Y., 1950, 597 pp., 235 fig., \$6.00.

592 QL362.B88 50-5864

Drawn largely from the summer-session faculty of the Marine Biological Laboratory at Woods Hole, Mass., the authors of this book are offering something distinctly new to the American educational world. The book is new from the very start. Its table of contents is the classification table from Phylum Protozoa, order Euglenoidea up to Phylum Chordata, order Stolidobranchia. Wherever one of the forms described in the book happens to fit in, there, and there only, you find its pagination. Sensible, isn't it? So is the rest of the book. Get it and see for yourself.

**SUBSPECIATION OF THE KANGAROO RAT, DIPODOMYS ORDII**, by HENRY W. SETZER, Museum of Natural History, University of Kansas, Lawrence, Kansas, 1949, 98 pages, 27 figures.

599.32 QH7.K3 50-63057

This monograph describes all 35 subspecies of *Dipodomys ordii*, Woodhouse, with a preliminary discussion of the paleontology, phylogeny, and dispersal of the form in its range from southern

Canada to the southern limits of the Mexican tableland.

**TEXTBOOK OF ANATOMY AND PHYSIOLOGY**, by C. C. FRANCIS and G. C. KNOWLTON, The C. V. Mosby Co., 3207 Washington Blvd., St. Louis, Mo., 1950, 624 pp., 365 figs., 31 color plates, \$6.25.

This is in many respects an unusual text. Including as it does both the anatomy and the physiology of the human body it should be a most useful manual for physical education and nursing courses. Although it is a second edition, about all that remains of its predecessor are the illustrations.

**TEXTBOOK OF BACTERIOLOGY**, by WILLIAM BURROWS, W. B. Saunders Co., West Washington Square, Philadelphia 5, Pa., 1949, 981 pp., 264 figs., \$9.00.

616.01 QR46.B84 49-10727

This sixteenth edition of what was once known as "Jordan's text" has, since his death thirteen years ago, developed through constant revision into a practically new manual. In its writing, the author was assisted by F. B. Gordon, formerly of the University of Chicago, R. J. Porter of the University of Michigan and J. W. Moulder also of the University of Chicago. The book is full of new and challenging electron microscope illustrations.

**TEXTBOOK OF HISTOLOGY**, by JOSE F. NONIDEZ and WILLIAM F. WINDLE, The McGraw-Hill Book Co., 330 West 42nd St., New York 18, N. Y. 1949. 456 pp., 287 figs., \$6.75.

611.018 QM551.N76 49-9439

This new book from a new approach, is designed to meet the needs not only of medical and dental students in histology but those of college biology majors also. (Since most of these may have had poor background training, and less knowledge of anatomy of physiology.) As such this is not a reference work. It is simply a beginner's book. Forty-six films available for teaching purposes are listed in the appendix.

**TEXTBOOK OF PHYSIOLOGY**, edited by JOHN F. FULTON and twelve assistants, W. B. Saunders Company, West



Washington Square, Philadelphia, Pa., 1949, 1258 pp., 556 figures, \$10.00.

612 QP31.H88 49-6974

This is the sixteenth new and thoroughly revised edition of a textbook of human physiology which originally appeared from the pen of William H. Howell back in 1907. Its long career in medical education will not be endangered or prejudiced under the august assembly of personages who coedited it nor by the roster of contributing authors who wrote the thirteen chapters of which it is composed.

TEXTBOOK OF PHYSIOLOGY, by W. D. ZOETHOUT and W. W. TUTTLE. The C. V. Mosby Co., St. Louis, Mo., 1949, 710 pp., 301 figs., 6 color plates, \$5.75.

612 QP34.Z6 49-48895

The heavily stamped silver design on deep red cover stock makes this book unfortunately look like some kind of correspondence-course engineering manual. This is really the tenth revised edition of a much reprinted and re-edited classical work on the subject. It is by no means the most massive volume on the subject now in use in this country, but it still remains one of the most satisfactory and practical.

UNRESTING CELLS, by RALPH W. GERARD, Harper & Brothers, 49 East 33rd St., New York 16, N. Y. 1949, 439 pp. 173 figs., \$4.00.

576.3 QH581.G35 49-9039

This is a re-issue of a unique and brilliant book, which originally appeared in 1940 and then went out of circulation as a paper-shortage casualty during the war. This is a layman's book rather than a teacher's, but it is fascinating reading just the same. The topics treated range through simple cell life, protoplasmic chemistry, enzymes, metabolism, irritability; growth, reproduction and aging; differentiation and Embryogeny, and heredity and genes. It could be used as a textbook but the course to which it applies would probably have to come under the survey classification.

VALLEY OF FLOWERS, by FRANK S. SMYTHE, W. W. Norton & Co., 101

Fifth Ave., New York 3, N. Y. 1949, 325 pp., 16 photographs in color. \$5.00.

915.42 DS485.B505S6 49-8900

Somehow or other the Himalayan Mountains carry a note of ruggedness and harsh inhospitality. This book should do much to correct that false impression. It is the story of six weeks spent in the Bhyundar Valley in the Garhwal Himalayas. The main part of the work is devoted to the experiences of the expedition. There are eleven pages of plant names identified in the valley listed in the appendix.

VOICES OF THE NIGHT, recorded frog calls of Eastern North America, Comstock Publishing Co. Inc., 124 Roberts Place, Ithaca, N. Y., 1949, \$6.50.

Whoever did the on-the-spot recording of these eight sets of frog and toad calls has really accomplished a very effective job. Anyone who has travelled at all at night, and stopped to listen near swamps, roadside ditches, or stream banks, must have been struck by the variety of amphibian voices contributing to the general springtime din. This set of records makes it possible to identify almost all of our eastern forms by actually hearing them. Nature students will welcome this unusual collection, the fidelity of whose reproductions can be vouched for.

YEAST CELL, its Genetics and Cytology, by CARL C. LINDEGREN, Educational Publishers, 122 North 7th St., St. Louis 1, Mo., 1949. Price not advertised.

589.2361 QR151.L66 49-11233

This is in many respects an unusual work. Its type is typewriter, its paging is by chapters, its illustrations are numbered similarly. Evidently it will be very welcome to students who can't count above 38 (the largest number of pages in a chapter). The illustrations are exceptionally good, most of them taken by phase microscope. Much of the work has been done by micromanipulation. The prevalence of non-Mendelian inheritance in tetrad analysis has caused the author to disavow any pro-Lysenko sentiments. The book lacks an index.

WAY TO GAME ABUNDANCE, by WALLACE B. GRANGE, Charles Scribner's Sons, 597 Fifth Ave., New York 17, N. Y., 1949, 365 pp., illus., \$6.00.

799 SK361.G76 — 49-11855

Long noted as leader in Wisconsin conservation policies and practices, the author of this unusually happy book, had much additional experience as federal and state biological survey officer. He has now settled down to the operation of a game farm of his own in central Wisconsin. In his book he offers a comprehensive explanation of game cycles, their causes and control. The four parts of the work successively treat of, the pattern of life, plant and animal successions, population cycles and the technology of game increase.

WEBS IN THE WIND, by WINIFRED DUNCAN, The Ronald Press Co., 15 East 26th St., New York 10, N. Y., 1949, 387 pp., 74 pl., \$4.50.

595.44 QL459.D8 49-11518

This book has already attracted so much attention that it would seem superfluous to do more than mention it here. It is something much more than traditional natural history, verging almost into a study of animal behavior in a small group of comparatively unknown animals.

WOODY PLANTS OF THE WESTERN NATIONAL PARKS, by V. L. and H. E. BAILEY, The University Press,

Notre Dame, Ind., 1949, 275 pp., 146 figs.

582.15 QK482.B23 49-3317

This manual of the Rocky Mountains and Pacific Slope woody plants first appeared as an issue of the Midland Naturalist. Included are the forms from the Southwest region as exemplified in the Mesa Verde, Bryce Canyon, Zion and Grand Canyon National Parks. In general the book covers all the parks west of the Rocky Mountain National Park in central Colorado. Because its flora has so many features in common with the more northern of the western national parks, Isle Royale in Lake Superior is included in the area surveyed.

THE WORLD OF LIFE, by WOLFGANG VON PAULI, Houghton Mifflin Co., 2 Park St., Boston, Mass. 1949. 653 pp. 524 fig. \$5.00.

There have been some professional criticisms of this textbook of general biology, particularly in regard to certain highly technical statements and interpretations. Even if these criticisms are valid it is highly probable that the average freshman would never suspect them, and certainly would not understand them. The book is built about evolution, from the physical backgrounds of life, through its rise and manifestation in the plant world, in the invertebrates and the vertebrates. It closes with the enduring principles of genetics, eugenics and euthenics.



## The Self-Survey

What do alumni and students think of the education their alma mater offers? How do they evaluate the teaching ability of the faculty, breadth of the curriculum and the reputation of Case?

The Self-Survey has the answers to these and many like questions. This survey organization, which has been at work for two years, obtained the answers from some 2700 questionnaires which alumni and students completed.

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which the college has made in the past year. The curriculum has been given greater breadth, an individual counseling system has been introduced for the entire freshman class, and a Freshman Week has been set aside for the orientation of students on their arrival at Case.

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—Case Alumnus.

## PHI SIG MAN IN CONGRESS

A charter member of Epsilon Chapter of Phi Sigma, Wayne N. Aspinall, was elected Congressman from the 4th District of Colorado and took his seat in the House of Representatives on



January 3 of this year (1949). Son of a pioneer of Colorado's peach growing industry, Aspinall has had a notable and distinguished career as a farmer, educator, lawyer and legislator and has been outstanding in his efforts for

sound development programs for water, soil, game and fish conservation and legislation working toward improvement of public schools, health and welfare.

The new representative goes to the nation's capital after an impressive career in the Colorado state legislature. He was elected to the Colorado house of representatives in 1930 and served until 1938 at which time he was elected to the state senate. He served as majority party whip in the legislative sessions of 1931 and 1933, and was speaker of the house in 1937 and 1939. He served as majority party whip in the state senate from 1939 to 1941; majority leader in 1941 and 1943; and minority leader, 1943-48.

Enlisting in the Air Service of the Signal Corps during World War I, Aspinall was honorably discharged as a flying cadet shortly after the armistice.

Although not a member of the Reserve, he immediately offered his services to the armed forces after Pearl Harbor. After a short period of training, he was sent to England as a legal expert, and was attached to the English Second Army with a small group of American officers. The early days of the Normandy Invasion saw Aspinall advancing with the English Second Army's drive into Belgium. Receiving his release, he returned home in time to discharge his duties as state senator in the 1945-46 assembly.

Aspinall's record shows a working belief in liberal policies of government, with a strong personal initiative for the development of the state and its people.



### Periodical News

"The Biologist" editorial of May 1949, "When Your Hobby Rides You," was run in its entirety in the March 1950 issue of "The Aquarium." This magazine is produced monthly by the Innis Publishing Company, 129 North

Twelfth Street, Philadelphia 7, Pa. Its subscription price is \$2.50 a year. Catering as it does to the amateur and the professional fancier of exotic fish, it is known throughout the world wherever aquarists abound.



## OUR EXCHANGES

*Annales de L'Acfas*: The French-Canadian Association for the Advancement of Science, Montreal, Canada.

*Bios*: Beta Beta Beta Biological Fraternity, Mount Vernon, Iowa.

*Carolina Tips*: Carolina Biological Supply Company, Elon College, North Carolina.

*Chi Beta Phi Record*: Chi Beta Phi Scientific Fraternity, Waverly Press, Baltimore 2, Maryland.

*The Filter*: Lambda Delta Lambda Physical Science Fraternity, Fairmont, West Virginia.

*Gamma Alpha Record*: Gamma Alpha Graduate Scientific Fraternity, Madison, Wisconsin.

*Hexagon*: Alpha Chi Sigma Professional Chemical Fraternity, Menasha, Wisconsin.

*Hormone*: Chemist's Club, Holy Cross College, Worcester, Massachusetts.

*Mendelian*: Spring Hill College, Mobile, Alabama.

*Messenger*: Theta Kappa Psi Medical Fraternity, Fraternity Press, St. Paul, Minnesota.

*Nyt Magazin for Naturvidenskaberne*: A. W. Broggers Boktrykkeris Forlag, Oslo, Norway.

*News Release*: Department of Lands

and Forests, Province of Ontario, Toronto, Canada.

*Ray*: Gamma Sigma Epsilon Chemical Fraternity, Gainesville, Florida.

*Serological Museum*: Rutgers University, New Brunswick, New Jersey.

*Sun*: Theta Kappa Phi, Maplewood, New Jersey.

*Sylva*: Ontario Department of Lands and Forests, Toronto, Ontario, Canada.

*Tabloid Scientist*: Catholic Round Table of Science, De Paul University, Chicago, Illinois.

*Technical Notes*: Lake States Forest Experiment Sta., University Farm, St. Paul 1, Minn.

*Turtox News*: General Biological Supply House, Chicago, Illinois.

*Ward's Natural Science Bulletin*: Ward's Natural Science Establishment, Rochester, New York.

*Wasmann Journal of Biology*: University of San Francisco, San Francisco 17, California.

*What the Colleges are Doing*: Ginn and Company, Boston, Massachusetts.

*Wisconsin Field Botany Report*: Botany Dept., University of Wis., Madison, Wis.



## Over-Specialization

Specialists in one field or "well-rounded-out personalities" with a liberal education—which should American colleges turn out?

Well, there have been encouraging signs here lately that colleges may begin aiming at the "well-rounded-out personality" which Max Shulman discussed in his satire on college life, "Barefoot Boy with Cheek."

In other words, colleges may be about to end their technological binge and start trying to produce educated men instead of one-track minds.

Over-specialization is creating a backlog of unemployed college graduates who might stretch from here to the moon.

Industry and business are more keenly aware of this fault of modern education than anybody. College faculty members know it, but don't or can't do anything about it. College placement directors, the people who have the responsibility of finding jobs for college graduates, know it now if they didn't before.—*Louisville Courier-Journal*.

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## Intellectual Ferment

It is our view that a college cannot educate a student, regardless of its able faculty and excellent facilities, unless he becomes an active participant in his own education. We believe in the process of learning through the activities of living in a stimulating atmosphere. George Williams seeks to provide this kind of climate. We can help the student to discover and develop his own abilities. We can assist him to overcome the obstacles that block his intellectual progress. To be sure, we want our students to know the facts of life, but we want them not only to know them but to understand their meaning. We try to teach our courses in such a way that students see the interdependence and interrelated unity of knowledge. All of it needs to be verified as far as possible by observation and testing. This procedure fulfills William James' thesis that college should be a place of "intellectual ferment."

The vitality of our kind of education in the last analysis will be determined by the quality of service rendered by our graduates. So long as the demand for them exceeds the supply, we could

rest our case and be content for a time. This is not the spirit of George Williams. We know that we do not live in a static world. This is especially true in regard to the world of ideas. The graduates of this College work mainly in the area of human relations and changing social conceptions. Each age has to interpret values in the light of contemporary conditions. Education should help youth to make these interpretations on a sound basis of judgment so that freedom tempered with justice will prevail.

We have a responsibility to encourage our students to study the important issues of our times. In a world so intimately related and intertwined as ours, we are compelled to deal with world problems as well as local ones. This situation calls for intelligent, accountable, participating citizens who will help to bridge the gap between the growing power of science and technology and the lagging practice of moral and social behavior.—Pres. H. C. Coffman, in *George Williams College Bulletin*.



## Mass Education

What we have before us in our colleges is a problem of mass education. It has for some time been fashionable to sneer at "mass production," "factory colleges," "assembly-line methods," and "department store" education. Those who sneer are wrong. They have failed to recognize, or they have failed to admit, that the universal education which has been farthest advanced in America, and on which rests in part the hope of American democracy and of Western civilization, is a problem of mass education. We hope to produce an educated people. It is a production job. It

is not only advisable that we apply to that job some of the also peculiarly American techniques of mass production; it is essential.

Most writers about education and most teachers are agreed that we must keep the ratio of students to teachers as low as possible if we are to teach effectively. It may be necessary to revise this judgment; it may be that, for the near term at least, our best progress may be made in another direction.—John S. Diekhoff, in *Journal of Higher Education*.

## American Association for the Advancement of Science

The American Association for the Advancement of Science, founded in 1848, and meeting with its Affiliated and Associated Societies in New York City, December 26-31, 1949, is the only national body representative of all the sciences. With its 211 affiliated and associated societies ( $\Phi\Sigma$  is associated with the AAAS) and state academies of science, it is by far the largest and most influential scientific organization in the world. These affiliates are grouped into seventeen sections and subsections—from A-Astronomy to Q-Education—each administered by a committee of six including chairman and secretary in addition to representatives of societies affiliated with the section. The Association has about 45,000 individual members most of whom elect to receive either *Science*—a weekly journal primarily for technical scientists; or *The Scientific Monthly*—an authoritative less technical treatment of progress in science.

(A member may receive both publications at a special combination rate by adding \$3.50 to the annual dues of \$6.50.) About one quarter of the membership have become fellows through their scientific contributions and attainments.

The AAAS seeks not only to further cooperation among scientists in all the diverse fields but also it is increasingly concerned with the improvement of human welfare and in a better public understanding of the interrelations of science and human progress. The sections are broad enough to include not only all professionally trained scientists who appreciate the place of science in our contemporary civilization but any person interested in science who wishes to keep informed, and who is concerned with the proper integration of science and human society. With great governmental research agencies on the increase and impending social legislation with scientific aspects, more than ever a strong, unified scientific association, representative of the clearest thinking in science is needed.

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### APPLICATION FOR MEMBERSHIP IN AAAS

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# PHI SIGMA BIOLOGICAL HONOR SOCIETY

"The object of Phi Sigma is to promote interest in biological research. Although always designated as an honorary biological research society, it should be considered as a working guild of biologists interested in research. In effect, election to Phi Sigma should be an opportunity for better work, rather than merely election to an honorary society."

## Mile Posts

- 1915 March 17, Alpha Chapter organized, Ohio State University, Columbus.
- 1916 May, Central Governing Body organized, BIOLOGIST first issued.
- 1917 June, last War-time BIOLOGIST issued.
- 1921 February, BIOLOGIST revived.
- 1924 December, First National Meeting, Constitution revised, Washington, D. C.
- 1925 December, Second National Meeting, First Science Program, Kansas City.
- 1926 December, Third National Meeting, Second Science Program, Philadelphia.
- 1927 December, Third Science Program, Nashville.
- 1928 December, Fourth National Meeting, Coat-of-Arms adopted, Fourth Science Program, New York.
- 1930 January, Council Meeting, Ritual Revised, Norman, Okla.  
December, Fifth National Meeting, Fifth Science Program, Cleveland.
- 1931 Phi Sigma Letters Registered, U. S. Patent Office.
- 1932 December, Sixth Science Program, Atlantic City.
- 1933 June, Sixth National Meeting, Seventh Science Program, Chicago.
- 1935 December, Seventh National Meeting, Eighth Science Program, St. Louis.
- 1937 December, Eighth National Meeting, Ninth Science Program, Indianapolis.
- 1939 December, Ninth National Meeting, Tenth Science Program, Silver Anniversary, Ohio State University, Columbus.
- 1941 December, Tenth National Meeting, Dallas, Texas.
- 1946 December, Eleventh National Meeting, Boston, Mass.
- 1948 December, Twelfth Meeting, Eleventh Science Program, Albuquerque, N. Mex.

The Constitution provides that: "A new active chapter may be established in any four-year degree-granting college or university . . . which is equipped with facilities for research in biological sciences to such an extent that at least one degree beyond the baccalaureate may be earned from that institution for biological research pursued there."